TRANSACTIONS

OF THE

AMERICAN INSTITUTE

OF

ELECTRICAL ENGINEERS,

VOL. II.

May 19th—20th, 1885.

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AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

ANNUAL MEETING.

May 19, 1885.

THE meeting was called to order at 8 P. M. on May 19, at the rooms of the American Society of Civil Engineers, New York city, by Mr. Rowland R. Hazard.

The Chair appointed as scrutineers Messrs. Frankland Jannus, Joseph Wetzler and Sidney F. Shelbourne, to canvass the ballots for officers.

The CHAIRMAN: I might say, while the balloting is progressing, that Mr. Stephen D. Field has sent in his resignation as a member of the Council, not of the Association, and it is proper that we should take some action upon that, because if some other name is to be substituted for his, it might be voted for now while the others are being counted.

Mr. F. L. POPE nominated as Manager in place of Mr. Stephen D. Field, Mr. William D. Sargent.

Mr. MARTIN seconded the nomination and it was carried.

The Secretary then prepared ballots and distributed them among the members.

The Secretary then read his report.

THE SECRETARY'S REPORT.

IT is provided by our sixth rule that a report of the proceedings of the Institute shall be furnished at the annual meeting. As Acting Secretary, I am glad, therefore, in fulfilling the requirements of the rule, to lay before the members and associates at our first annual meeting, statistics of the most encouraging character.

Under the circumstances familiar to most of the members present, this society came into existence just a year ago. It has already 279 members and associates, in all parts of the country. From the numerous inquiries addressed to the Secretary and Council, as to the objects of the Institute, the steady increase in the number of applications for admission, and the work done durin the past twelve months, it is evident that the Institute will soon compare in strength and usefulness with the older engineering societies, upon which it has been modeled.

As will appear more fully from the Treasurer's report, the sum of $2,315 has been raised during the year, and the sum of $1,454.68 expended, leaving a balance of $860.32.

Soon after the formation of the society, the Directors of the International Electrical Exhibition held at Philadelphia, under the auspices of the Franklin Institute, tendered to it the free use of rooms in the exhibition building as long as it remained open. The offer was accepted by the Council, and the Secretary was authorized to make the necessary preparations and to be present during the Exhibition as the representative of the Institute. The rooms were accordingly prepared, and were opened to members on September 2d, remaining open until October 11th. They were visited by a great many members and by several foreign electricians. On Oct. 7th and 8th a meeting was held, partly at the Continental Hotel and partly at the Exhibition rooms, when papers were read and discussed. On the invitation of the Franklin Institute, the Exhibition was also inspected by the members in a body.

The first volume of the Transactions of the Institute was published in March of this year. It contains a historical preface detailing the steps taken to organize the Institute; the rules and regulations; and the eleven papers read at the Philadelphia meeting. As the Institute is still so young, it may not be out of place to note that the volume has been given a most cordial welcome at home and abroad, and has been the subject of several complimentary reviews in the scientific press. Of the one thousand copies printed, about three hundred have been distributed.

The Institute is without a permanent home, but has not been under the necessity up to the present time of paying rent for offices. All the meetings in New York, of the Council and the Institute, have been held at the house of the American Society of Civil Engineers, through whose Secretary, Mr. John Bogart, every possible facility and courtesy has been extended. Several of the scientific and engineering societies of this country, Canada and Europe, are desirous of exchanging publications with the Institute, but so far no place has been provided the Secretary for the accommodation of a library or for the storage of the printed transactions, copies of the rules and other property.

It has, however, been suggested, that the scientific and artistic societies of this city shall combine to secure a permanent, handsome and fireproof structure, wherein to place the valuable libraries, models, specimens, etc., that are rapidly accumulating in their hands, and where offices and meeting rooms shall be set apart for each of the combined organizations. The Council have, on behalf of the Institute, given their support to the proposition, which is now assuming shape and is under the consideration of a joint committee.

T. C. MARTIN,
Acting Secretary.

May 18th, 1885.

The CHAIRMAN: You hear the report of your Secretary for the past year, what is your pleasure in regard to it.

Dr. NORVIN GREEN: I move that it be accepted and placed on the records of the Society.

Agreed to.

Col. HAZARD read the Treasurer's report.

THE TREASURER'S REPORT.

The American Institute of Electrical Engineers, Cr., in account with Rowland R. Hazard, Treasurer, Dr.

SUMMARIZED ACCOUNT.

To Cash received from Members		$2,315 00
By T. C. Martin, Sec'y, (6 months)	$300 00	
" N. S. Keith	441 22	
" Printing	594 26	
" Stationery and Books	70 25	
" Copying	10 00	
" Signs	10 00	
" Petty Expenses	28 95	
" Balance in Bank	860 32	
	$2,315 00	$2,315 00

E. and O. C.

ROWLAND R. HAZARD,
Treasurer.

New York, May 19th, 1885.

On motion of Dr. GREEN, the Treasurer's report was accepted and ordered to be placed upon the records.

Mr. PHELPS: I offer the following resolution:

Resolved: That the thanks of this meeting be tendered to the American Society of Civil Engineers and to Mr. Bogart, the Secretary, for the use of the rooms of the Society for meetings during the past year, and for other valued privileges and courtesies extended to this Institute.

The resolution was seconded by Mr. **Martin** and carried unanimously.

The **Chairman**: The Secretary is requested to send a copy of the resolution to the Society of Civil Engineers and another copy to the Secretary of that Society.

Mr. F. L. **Pope**: Mr. Chairman, I have a resolution I would like to offer:

Resolved, that the thanks of the Institute be tendered to Dr. Norvin Green, for the active interest he has taken in the wellfare of the Institute and for his invaluable services as its President during the past year.

The resolution was seconded by Mr. F. W. **Jones**.

The **Chairman**: Gentlemen, you have heard the motion. I think there cannot be two opinions concerning the value of Dr. Green's services to the Society. His name is of world-wide significance and nothing could have added more to the importance of the undertaking in the public estimation, I am sure, than the fact that he occupied the presiding chair. If it be your will that this resolution pass, you will say Aye.

The resolution was carried unanimously.

Mr. **Jones**: I think it is due that we should give an expression of our thanks to our retiring Secretary, for his very valuable services. I have not written it down, but it is quite as good orally, and I would make a motion that we tender to our retiring Secretary, Mr. Martin, our thanks for his attention and for the ability with which he has discharged his duties.

Mr. F. L. **Pope**: I would second the motion, Mr. Chairman. I am sure we all appreciate Mr. Martin's services. He stepped into the breach at a critical time; he has carried on the work with great inconvenience to himself, has always attended every meeting punctually, and I am sure we all owe a great deal to him—a great deal more than we can express by any resolution for the service he has been to us.

The **Chairman**: You hear the motion, gentlemen. I most heartily concur in it myself and I suppose that every member of the Institute who is at all aware of the importance of Mr. Martin's services to us, at a period when there was literally no one to attend to the affairs of the Institute, except himself, most heartily concurs.

The resolution was carried unanimously.

The **Chairman**: Mr. Martin will collect the ballots for Mr. Sargent's election.

Mr. **Sherbourne**: The committee to canvass the ballots beg to report that the whole number cast was 84, of which 68 were cast as printed. In regard to the election of a manager to supply a vacancy Mr. Sargent received a unanimous vote. The ticket, as printed, is therefore elected by a very large majority.

The **Chairman**: The Chairman of the Committee of Scrutineers, so-called in our fundamental law, has reported to you, gentlemen, the election of the officers for the ensuing year, and they are: President, Dr. Norvin Green; Vice-Presidents, D. H. Bates, A. E. Dolbear, Francis W. Jones; Managers, Charles L. Buckingham, David Brooks, T. C. Martin, George M. Phelps, Jr., Prof. B. F. Thomas and W. D. Sargent; Treasurer, Rowland R. Hazard; Secretary, Ralph W. Pope. These gentlemen are elected by nearly a unanimous vote as your officers for the ensuing year.

The **Chairman**: Our business, I think, is concluded for the evening, and I beg to call it to your attention, gentlemen, that to-morrow the general meeting occurs here at ten o'clock in the morning, and will continue through the day with some refreshments that have been provided at noon time or thereabouts. Five papers will be read, "The Protection of Electrical Inventions," by Mr. Frankland Jannus; "The Storage Battery in Commercial Use," by Mr. E. P. Roberts, M. E.; "The Cost of Mine Lighting," by Mr. F. P. Mills; "The Electric Arc Lamp Frictional Clutch," by Mr. Edward P. Thompson, M. E.; and the "Delany System of Fac-simile Telegraphy," by Prof. E. J. Houston. A collation will be provided between the morning and afternoon sessions and members are permitted to introduce friends. Is there any other business before the meeting?

Mr. **Martin**: I have no business as secretary, Mr. Chairman. I would like to advise members that if they wish to make any amendments to the rules, now is the opportunity. Any notices given now can be considered to-morrow.

The **Chairman**: What, if any, amendments occur to you, Mr. Martin?

Mr. **Martin**: A great many, sir.

The **Chairman**: I mean of any moment. The Secretary naturally is the one to discover any defects in the working of the organization.

A **Member**: I should like to ask, if it needs a formal amendment to change the word scrutineers to something else. It sounded very funny a year ago, and when the word came to be applied to myself, personally, I did not like it.

The CHAIRMAN: I am not surprised that any one should resent the application of that term to himself.

Mr. SHELBOURNE: I learn that the word was brought into the rules of this Society from the Society of Mining Engineers, and I can readily understand how a Society of Mining Engineers who have to do with caverns under the earth, should peer and "scrutineer" around in order to see something. I make the formal motion, that the rules be amended by substituting in the place of the word "scrutineers" the word "tellers." The word tellers is recognized in the Revised Statutes of this State as belonging to those persons who count the votes at an election of directors or trustees of a corporation, and it seems to me that that word would be more appropriate and sound better.

The motion was seconded by Mr. Martin.

The CHAIRMAN: The word scrutineers is certainly preposterous, if nothing else. Is it your pleasure that the rules be amended by striking out that word?

Mr. SHELBOURNE: I beg to say that, as I understand the rules, the amendment cannot be adopted at this meeting. My motion is therefore, that it be written out and proposed as an amendment here this evening to be considered by the meeting to-morrow.

Mr. MARTIN: The eighth rule provides, Mr. Chairman, that these rules may be amended at any regular meeting by a two-third vote of the members present, provided that written notice of the proposed amendment shall have been given at a previous meeting. That written notice should be given in to-night and the matter can be considered to-morrow.

The CHAIRMAN: Then the motion is that a written notice be now given.

Mr. MARTIN: With regard to the rules generally, there are one or two points that really deserve consideration by the members. Of course, it is natural, that in adopting rules various points should be overlooked and their deficiencies found out only when the members come to work under them. In rule 5, for instance, relating to elections, there seems to be a contradiction. It says this: "The annual election shall be conducted as follows: Nominations may be sent in writing to the Secretary, accompanied by the names of the proposers, at any time, not less than thirty days before the annual meeting; and the Secretary shall, not less than two weeks before the said meeting, mail to every member or associate (except honorary members) a list of all the nominations for each office so received, stamped with the seal of the Institute, together with a copy of this rule and the names of the persons ineligible for election to each office. And each member or associate, qualified to vote, may vote, either by striking from or adding to the names of the said list, leaving names not exceeding in number the officers to be elected, or by preparing a new list, signing said altered or prepared ballot with his name, and either mailing it to the Secretary or presenting it in person at the annual meeting."

You will notice that he may add to the list, although he has not made the nomination which is provided for at the beginning of the rule. It is a stultification. I experienced that difficulty in trying to work the rule. It throws a great deal of unnecessary work on the Secretary, for, after he has done all that has been provided, a member may scratch the ballot through and make the nomination even at the present hour of the annual meeting.

Then there is another point with regard to membership in connection with Rule 2. This, as several of the members know from correspondence with myself, is a point that is not at all clearly understood. The rule provides, that associates shall include persons practically and officially engaged in electrical enterprises; it being already provided that members and honorary members shall be professional electrical engineers and electricians. I fail myself to distinguish the difference that is there implied. The council, in working that rule, experienced difficulty at the very first, and in order to mark out clearly its view with regard to the qualifications for a member, it provided the following conditions upon which all associates or others wishing to become members should enter as members.

"Qualifications for a member: He shall have practised on his own account or in the service of some individual, or organized institution or company engaged in electrical work, in the capacity of electrical engineer or electrician, for at least two years, or he shall be so intimately associated with the science of electricity, or the art, that the Council consider his admission to membership would conduce to the interests of the Institute."

I find that in the working of the rules, that a great many take offense at the idea that they are not able to come into the Society directly as members, and they contend that rule 2 provides, that they can come directly into the Society as members without passing under any such restriction as that, subsequent to their balloting. I should be very glad to have that point dealt with for the benefit of my successor. I know it will relieve him from a tremendous lot of unnecessary correspondence. We have at present some sixty or seventy full members, and in almost every case I have had to explain what that means, and I am afraid that the idea is very confused and misty in the minds of most of the members, and I am willing to confess that it is somewhat confused in my own. I would like to have that point dealt in some shape, although I am not prepared to move an amendment. There are one or two gentlemen present with whom I am in correspondence at this time on that point. They have brought gentlemen into the Society who are electrical engineers in the fullest sense of that word, and I have had to write to them that they can be only associates. The Council will have to say whether they can be full members or simple associates, and gentlemen take exception to that.

The **Chairman**: You might appoint a committee to revise the rules.

Mr. **Martin**: I think I have written at least a hundred and fifty letters on that point, and it seems to me it should be unnecessary on such a material point.

Mr. F. L. **Pope**: I think it would be an excellent idea to appoint a Committee of Revision and put on that committee some of the persons who have had practical experience in trying to work the rules as they are now. It is perhaps a little misty what the author of the rule did mean by what he said. I must confess that, like Mr. Martin, I do not understand it, and I think that a committee, familiar with the subject, could hit on some plan of modification that would be self-explanatory and which would do away with most of the difficulties that the Secretary speaks of. I make the motion that a committee of three be appointed by the chair to prepare such amendments to the rules and submit them to the Institute.

Mr. **Martin**: I second that motion, and in doing so, I would like to say that the President of the Society has rather strong feelings on the subject. He thinks that that rule more than any other calls for revision and has so expressed himself, I think I am at liberty to say, in the council meetings.

Mr. **Shelbourne**: It seems to me that under the rules, as they now stand, this committee, being appointed at the present time, would have to consider and report this evening, in order that a written notice of the proposed amendment could be submitted to the members to-morrow.

The CHAIRMAN: I think the subject rather large to deal with this evening. We had better leave it.

Mr. JANNUS: I think, by a rather liberal construction of these rules, we might appoint a committee with instructions to report at once as a notice, and consider their report to-morrow.

Mr. MARTIN: There are two other points to which I wish to call attention, if I am not boring the members. It says here in Rule 6: "The Annual Meeting of the Institute shall take place on the 3d Tuesday of May, at which a report of the proceedings of the Institute and an abstract of the accounts shall be furnished by the Council. Two other regular meetings of the Institute shall be held in each year, at such times and places as the Council shall select, and notice of all meetings shall be given by mail or otherwise, to all members and associates, at least twenty days in advance. Special meetings may be called whenever the Council sees fit; and the Secretary shall call a special meeting on a requisition signed by fifteen or more members." It will be seen that to-morrow's meeting is entirely distinct and independent of this, and in that way there is full propriety in considering any amendments that may be presented; but there is a point in connection with the rule. Several of the members in New York have written to me and have objected to the infrequency of the meetings held during the year. They say that the members ought to be brought together in New York oftener, that papers might be presented and read, and that the New York members might form a branch or a sub-section of the Society, and they think that the Society would be greatly strengthened by some such step as that; but it will be seen that Rule 6 makes no provision at all for any meetings of that nature, except that they shall be called whenever the Council sees fit, and that the Secretary shall call such a meeting on a requisition signed by fifteen or more members. It seems to me that the Society would derive benefit from occasional meetings of the New York members. The New York Electrical Society has papers presented in that way, and a great many of them are of interest and value.

The CHAIRMAN: I think a committee to consider these rules ought to have time, and I think, if a committee was appointed to-night, there will be no necessity for them to report to-morrow, as a special meeting may be held within thirty or sixty days. We have gone through the first year and it would seem that all the amendments that are likely required would be already perfectly clear in the minds of the Executive Officers of the Institute. It would seem to me, therefore, if we should appoint a committee to-night to report whenever a special meeting is called, within thirty or sixty days, we might also make that an interesting occasion for other reasons. That would give some little time for everybody to consider these rules and to confer with the committee as to the propriety of changes. I understand it to be moved that a committee of three be appointed by the chair to report. The question is, shall it be to-morrow or at the next meeting.

MR. JANNUS: I suggested that it report at once for the purpose of overcoming the technical difficulty in the way of Mr. Martin's successor. I shall withdraw that, of course, in view of the suggestion of the chair. If the committee intends to go into the subject deeply enough to afford permanent relief, I think it would be far better for the Council to call a special meeting to consider their report.

MR. JONES: I think that it is highly important that the Institute should place itself properly before the electrical talent of the country, and that as soon as possible they should know their status. Now it seems to be defined in a peculiar manner, as has been pointed out by the Secretary, and a person who is engaged in any electrical work hardly knows whether he is elegible to come in as a member or associate. The same prevails in other professions; you will find signs in the street of professional haircutters and practical haircutters. I do not see the distinction. Then there are practical tailors; what a theoretical tailor may be I do not know. I think, if we take steps to-night to have that particular part rectified, it would be the means of a large accession to our membership. But if it is left for a few months, it will deter persons whom we will be very glad to have connected with us, from sending in their names.

MR. F. L. POPE: I think it would be an excellent idea for this committee to invite suggestions from all the members as to any alterations in the rules that they may think advisable, and in that way they will probably get some suggestions that would be worthy of consideration, and it might be well to invite such suggestions at the meeting to-morrow from the members then present. I think the committee will find it of material aid to them.

The **Chairman**: That committee might report on the 10th of June, for example, in order not to defer it too long.

Mr. **Jones**: Have an adjourned meeting from to-morrow.

Mr. **Phelps**: I think, Mr. Chairman, the motion might be put in some such way as this: That a committee be appointed to prepare a general revision of the by-laws wherever they think it is required, and to report within some specified time and request a meeting to be called at once thereafter. It seems to be a very important question, and I have no doubt a very large attendance will be secured at such a meeting, and the committee might finish its labors in ten or fifteen days possibly; but I certainly feel that the matter requires very careful consideration and nothing need be done in a hurry.

Mr. **Martin**: I have been in correspondence with gentlemen who wanted to join, and simply because they could not come in as members in the full sense of the word, they have ceased their correspondence. If they knew exactly the conditions upon which they were to enter the Society, I think electricians would come in much faster than they do now. It has been no small burden to me for the last six months to explain what that rule meant.

Mr. **Shelbourne**: It seems to me, with regard to this special meeting, the difficulty will be that, being a special meeting for this purpose, it will not be largely attended. To-morrow being the general meeting after the annual meeting, I assume that there will be a large number of members in New York city, who are here for the purpose of attending this meeting and hearing the papers read. As the principal thing to be done in regard to these rules is in regard to that one in relation to the qualifications of members and associates, I would suggest that an amendment of that rule might be made at once by the committee, so that that could be considered to-morrow and suggestions could be received at the meeting to-morrow, and if the meeting did not propose to adopt it to-morrow, then the meeting to-morrow might defer the adoption of it until some other time. It would be desirable to take the views of a large number of members or associate members, as they may be called, it seems to me, to-morrow on this subject, in order to have the matter put in as nearly practical a shape as possible, as soon as possible. As for myself, I was among the first to sign the rule for the membership of the Society, and I never stopped to consider whether I was an associate member or a member, because I never have been able to discover and I have never been informed that there is any difference in the amount of collation we will receive to-morrow whether we are members or associates; or in relation to any of the privileges or emoluments of this Society (if there are any emoluments), as to whether we are members or associate members. But I learned to-night for the first time that there is a great feeling on this subject, and I think the question ought to be begun to be settled as soon as possible.

The CHAIRMAN: Suppose that the regular meeting to-morrow shall adjourn to the 17th of June, the subject could be continued. I am strongly inclined to think that you could not modify that rule satisfactorily at very short notice, particularly as the committee ought to consist in the nature of things of the outgoing and incoming Secretary and President.

Mr. JANNUS: I would like to ask, if this printed memorandum would make a satisfactory change in the rules:

"He shall have practiced on his own account, or in the service of some individual, or organized institution, or company engaged in electrical work, in the capacity of electrical engineer, or electrician, for at least two years, or he shall be so intimately associated with the science of electricity or the art, that the Council consider his admission to membership would conduce to the interests of the Institute."

Mr. MARTIN: That has been considered satisfactory to every gentleman who has seen it; but the point is this—a gentleman presents himself for entrance in the Society; he says, "I am an electrical engineer engaged in electric lighting; can I become a member?" I have to send word back to him and say: "No, you can become an associate, and if the Council say so, you can become a member;" and they take umbrage. The Council has rejected the application of two or three associates in view of that clause.

Mr. F. L. POPE: I think it is rather important there should not be any hasty action taken on those rules. When we amend them this time, we do not want to have to do it over again. We might as well make a thorough job of it, and I think we have had sufficient experience in working the rules, to find out most of their defects, and it has occurred to me, that we might get at the sense of the whole society perhaps in this way, by having the committee prepare a draft of the rules, have them printed, and a copy sent to every member to invite suggestions, before presenting it in this final form, the committee being, of course, at liberty to adopt such suggestions as they please, or to pay no attention to those that they do not consider worth paying attention to. In that way every one would have a hearing, and no one could complain that his ideas had not been considered, and it would not take very long to do that, and the probability is that very few amendments would be suggested, so that I presume we should find the rules would be left substantially as the committee decided upon them in the first place.

Mr. **Shelbourne**: I indorse that view very thoroughly.

The **Chairman**: The resolution then would take the form, that a committee of three be appointed for the revision of the bylaws of the Institute, and that they be requested to report to a general meeting to be held within the month of June, which meeting shall be an adjournment of the regular meeting to-morrow. When the meeting to-morrow adjourns, it will adjourn to Wednesday, the 17th day of June, or a meeting might be called by the Council on the 17th of June.

Mr. **Martin**: Wouldn't it be better after all to give the committee time and adopt Mr. Pope's suggestion of a thorough canvass of the members, so that it can come up at the next regular meeting. I think three or four months is not a very long time to wait

The **Chairman**: Then the committee, when it is ready to re port, will request the Council to call a special meeting.

Mr. F. L. **Pope**: That will be better, I think.

The **Chairman**: Then the resolution will simply be for the appointment of a committee of three for the purpose of revising the by-laws and with power to adopt such a course to ascertain the consensus of opinion as they may elect to do and to report, and with authority to request the Council to call a meeting.

The resolution was adopted.

The **Chairman**: I will appoint as committee on the last resolution, the retiring Secretary, the incoming Secretary, and Dr. Green.

Mr. **Shelbourne**: In view of the motion just passed I ask leave of the meeting to withdraw my motion in regard to the word scrutineer, and let that subject come before the committee for action with the rest.

The Chairman: There is no objection to that withdrawal.

The Secretary suggests that I say something about a plan for securing a permanent home for the Society. A committee of four has been appointed by this Institute and a larger committee by the Society, which is our host here, and committees have been appointed by one or two other societies. The general plan is to get one of the large estates like the Astor or Rheinlander to put up a large fire-proof building to accomodate twenty-five or thirty societies, which have common purpose, scientific or artistic, in preserving their records, their libraries and their specimens, and to make a common rallying point for the scientific and artistic world in this city, which is the commercial centre of the United States. That committee that has it under consideration, has had one meeting and is to have another, and is in treaty with one or two estates. It is thought, that with thirty or forty societies, particularly if we could include societies of considerable membership and age, like the Historical and Geographical societies, that a great estate would think them good tenants and be glad to take them on a lease of twenty-five years, so that a permanent home for the sciences and arts could be had here. I do not know that any action of the Society is desirable at the present moment, but we very much hope that the committee will be able to report soon that an arrangement has been made to accomplish that greatly to be desired end.

Mr. MARTIN: I would like to say with reference to our Chairman's very interesting statement, that is highly desirable we should have some sort of place we can call our own. It would be far more interesting to the members to know that they have a place where they can go, a place that will compare in some sense with this, in after years. I may say that I have now on my hands some three or four hundred dollars worth of property, and I think that that should be deposited in some place. I have at least seven hundred copies of the Transactions and two or three thousand copies of the Rules. I have had several applications from various societies in Europe and here for an exchange of proceedings, but in every case I have had to decline present acceptance on the ground, that I have no place in which to deposit such valuable papers that might be sent in exchange, and I think it would be very encouraging for the Council, if they could have in any shape an expression of opinion from the Society of approval of the step that was being taken in this matter in joint action with the other engineering and artistic societies.

Mr. F. L. POPE: I would like to make a motion that the

Council be authorized to hire a small room at moderate expense in some convenient and safe place for the storage of their records and books, etc., temporarily for the coming year or until we get quarters of our own of some sort. It would be much better to do that, and it would cost us but very little. I think it would be an excellent thing to do. It need not be an expensive room or a large room, or in a very conspicious place. It could be used mainly for the storage and keeping of the property we have, and if the Society will authorize the Council to procure such a room, and leave it to their discretion, I think it can be arranged without any difficulty.

Mr. **Martin**: I would like to say, sir, as an instance of the necessity of some such place, that at Philadelphia there were many interesting exhibits which the exhibitors were anxious to hand over to the Society. But we had no place to put them, and the Franklin Institute has profited by our want of such a place. I do not begrudge them to the Franklin Institute, but I think it would be very desirable to have a museum for the Society, which might be of great value by and by.

The motion to authorize the Council to secure a room was carried.

Mr. **Jones**: It has just occurred to my mind that our esteemed President is pretty well burdened in duties. He has been very attentive at all our Council meetings, and has had considerable committee work given to him, and I have just heard his name mentioned in connection with a very important work for us, and while he would be eminently fitted to carry out the work, had he the time; I do not think it would be right for us to impose on him to that extent, and then we have electricians and others in our own ranks to such extent, that we are capable of keeping young men for labor and old men for council, and I think it would be proper to relieve our President from that duty. I am not a candidate for that office, nor am I able to perform its duties.

Mr. F. L. **Pope**: It seems to me, Mr. Chairman, that we need not throw a great deal of the work on our respected President, and in fact, I think, your idea in appointing him was, that he should have the casting vote, as it were, and have the work done by the other members of the committee submitted to him, rather than to impose upon him any active duties in connection with it. I do not think that is necessary. I think the retiring and the incoming Secretaries can lay out the work, and I think it would be eminently advisable to submit it to Dr. Green for his suggestions, as he has had a great deal of experience in matters of this kind, and as we all know, is a man of remarkable common sense about such matters. I hardly think that we need deprive ourselves of the benefit of his counsel on that committee.

Mr. Jones: I agree with all Mr. Pope has said, and I beg to say that Mr. Green is an ex-officio member of that committee anyway.

The Chairman: The only thing I object to in the resolution is, that Dr. Green is spoken of as an old man. If you are to judge a tree by its fruits, he is still young. I think that Mr. Martin and Mr. Pope are both competent to deal with that subject, and that the committee is a good one as it stands. Dr. Green's counsel will be desirable and it has been stated by Mr. Martin, what I did not know before, that he has a good deal of feeling and a distinct opinion on that subject. I think that had better stand, unless it is the sense of the meeting otherwise. The objection has been made to me, that no member of the committee is an active electrician, but I do not know that that is a serious objection. They are both very sensible men and both have had considerable experience in this particular department. Mr. Martin has given much attention to that rule and has lost in mind, body and estate through it.

Mr. Martin: I would like to say that I would be glad to give a good deal of time to the revision of the rules, and I would also like to inform our Chairman, that Dr. Green at one of the very few meetings, from which our Chairman was absent, expressed himself in very strong language indeed with regard to that rule. I think Mr. Pope was present and will bear me out in that statement. He spoke to the point for several minutes and expressed his earnest wish to have some reconsideration of that rule, so that it be in one sense more liberal and in another sense more restrictive, that it would take in all who were worthy and at the same time let those who were not, know it. As it is now, it is vague in the extreme. I would like to have a professional electrician (I am not one) on that committee.

Mr. Jones: That was my idea exactly. There is not a professional electrician on that committee.

Mr. Martin: I should be very reluctant to pass dogmatically on what constitutes the status of professional electricians? Will Mr. Pope serve on that committee with us?

M. F. L. Pope: I do not object, sir.

Mr. Jones: Make the committee five, and I would like to include Mr. Hamilton.

The Chairman: It is moved that the committee be increased to five, and that Mr. Pope and Mr. Hamilton be added to the committee.

The motion was carried.

The meeting then adjourned.

GENERAL MEETING.

The General Meeting was called to order at 10 A. M. on May 20th. Mr. **Shelbourne** in the Chair.

Mr. **Martin**: I move that a committee be appointed by the Chair, to determine the order of the presentation of the papers to be read at this session.

Agreed to.

The **Chairman**: I will appoint Mr. Hamilton, Mr. Pope and Mr. Phelps as that Committee. If the Committee will retire to the rear room with the Secretary, they can confer there and report as soon as the matter is determined.

The Committee then retired.

The **Chairman**: The Committee have reported and the order has been determined as follows: The first paper to be read is "The Protection of Electrical Inventions," by Mr. Frankland Jannus; second, "The Cost of Mine Lighting," by Mr. F. P. Mills; third, "The Electric Arc Lamp Frictional Clutch," by Mr. Edward P. Thompson, M. E.; fourth, "The Storage Battery in Commercial Use," by Mr. E. P. Roberts; fifth, "The Delany System of Facsimile Telegraphy," by Prof. Houston. The first paper therefore in order, will be "The Protection of Electrical Inventions," by Mr. Frankland Jannus, who will now proceed to read his paper.

[The reading of the various papers and the consequent discussions then followed in their regular order, as they appear herein. After the discussion, on Mr. Thompson's paper, an intermission of two hours occurred, during which the members and guests partook of a collation. The opening business of the afternoon session then followed, after which the regular order was resumed, beginning with Mr. Robert's paper.—Editor.]

AFTERNOON SESSION.

The meeting was called to order at 2.30 P. M.

The CHAIRMAN (Mr. SHELBOURNE): Your Chairman asks for relief from duty as chairman of the afternoon session.

Mr. F. L. POPE: I move that the Chairman be excused, with the thanks of the meeting, for the courteous and agreeable manner in which he has presided over our deliberations, and if it is in order I would nominate Mr. Frankland Jannus, of Washington, as our presiding officer for the afternoon session.

The nomination was approved and Mr. Jannus took the chair.

The CHAIRMAN: Before proceeding with the reading of the next paper, I have to announce the receipt of a telegram from Mr. George C. Mason, Secretary of the American Institute of Architects: "To the Secretary of the Electrical Engineers: Regret inability to be at your annual meeting. Accept best wishes and fraternal greetings."

Mr. MARTIN: Captain Michaelis has a resolution to offer on the subject of electrical units, and also in regard to the investigation of structural materials, and Mr. Roberts has kindly consented that his paper be deferred until this matter is disposed of.

Capt. MICHAELIS: I must apologize for encroaching even for a very brief period upon the attention of the Institute, and also for being instrumental in deferring for a few minutes the paper of Mr. Roberts, in which we all are interested.

You may recollect that last fall, at the meeting of the National Conference of Electricians, among whose members I notice that the Institute is so largely represented, a motion was made, after an animated and prolonged discussion relative to the Governmental establishment of electrical and other units, that a committee be appointed to attempt to secure government aid in such establishment, and also, that the same course be taken in reference to the electrical investigation of the physical qualities of structural materials, a matter in which all engineers of every name and kind, are exceedingly interested, and in order to merely test the sense of the Institute whether it be considered a proper subject to be acted upon by its representatives, I thought it best to crystallize the matter into a resolution, which I have drawn up very hastily and which, of course, is subject to verbal and other amendments:

Resolved, That the Chairman appoint a committee of five members, to act independently or with a similar committee appointed by the President of the U. S. Electrical Commission, for the purpose of obtaining Government aid in the establishment of electrical and other standards, and in the electrical investigation of the physical quantities of structural materials.

I put in the word independently, because the committee appointed by this Institute might be in shape to act at a time when perhaps the other committee might not be, and it was simply to give them that latitude that I put in that modifying clause.

The **Chairman**: Do you think the Conference would co-operate with a committee of this Institute?

Capt. **Michaelis**: I think so. There are others here, beside myself, who are members of the Conference. I propose to bring the subject to the attention of the President, Prof. Rowland of the Johns Hopkins Institute.

Mr. **Martin**: I would like to ask whether that could not be more closely defined, as to whether the Council or members is meant.

The **Chairman**: Does the mover of the resolution desire that this committee be appointed by the Chair or by the Council?

Capt. **Michaelis**: Whichever way would be most expedient. There is no immediate hurry for the appointment of a committee. Let it be the President of the Society or the Council, whichever is the usual course. I know that in kindred societies of which I am a member, it is usually the permanent president of the society who appoints such committees, after he consults, of course, with his "constitutional advisers."

The **Chairman**: The reason I asked the question was, that the Council is the permanent governing body here, and they would perhaps be far better able to appoint a committee than the temporary Chairman.

Mr. **Martin**: I move that it be amended by substituting Council for Chairman.

Capt. **Michaelis**: I accept the amendment.

The resolution was adopted.

The **Chairman**: We will pass now to the reading of the fourth paper, the title of which is "The Storage Battery in Commercial Use," by Mr. E. P. Roberts.

PRELIMINARY REMARKS ON THE DELANY SYSTEM OF FAC-SIMILE TELEGRAPHY.

The CHAIRMAN:—The fifth and last paper for to-day relates to the Delany System of Fac-simile Telegraphy, by Prof. E. J. Houston, of Philadelphia.

Mr. MARTIN:—Prof. Houston is ill and not able to be present, and under those circumstances I have asked Mr. Pope to read the paper. It did not reach me until between 4 and 5 o'clock yesterday afternoon. It is not altogether easily decipherable; but Mr. Pope has kindly volunteered to read it, although I fancy he must have experienced some difficulty in making out its contents. In case he has not been able to read it through, I suggest that he make a general statement on the subject and that the paper be taken as read; if that course is agreeable to Mr. Pope.

The CHAIRMAN:—If there is no objection that course will be pursued.

Mr. F. L. POPE:—This paper has only been placed in my hands since I came here this morning and I have snatched a few moments, as I had opportunity to look over it. It is accompanied by a number of diagrams, which, if I were more familiar with the subject, I might sketch out on the blackboard. Instead of attempting to read the paper it may perhaps be sufficient as we shall have it printed in due time to give a brief summary of what I think is in it.

Mr. Patrick Delany exhibited at the Philadelphia Exhibition, last year, a synchronous multiplex telegraph. This telegraph was shown in successful operation, and probably many of those here present had an opportunity to inspect it; possibly some may also have seen it in operation between Boston and Providence, where it was in practical use some time ago and I presume is to this day. I had an opportunity of examining it at work between Boston and Providence, in company with Mr. W. H. Preece of the British Post Office Telegraphs, who was over here last year, and its operation was quite satisfactory. The wire on which it was working was not far from one hundred miles in length, reaching from Boston to Providence and back to Boston again, and over this length of line, I consider that the transmission of messages six and eightfold was practically successful. I am sure we all regret that Prof. Houston is not here to read the paper himself, as he would have made the matter very interesting and very clear. He has taken a great deal of interest in Mr. Delany's system and has afforded the inventor a great deal of valuable assistance in bringing it before the public.

[Mr. Pope then gave an explanation of the fac-simile system of Mr. Delany, which is omitted, the paper appearing elsewhere in full. Editor.]

DISCUSSION.

The **Chairman**: I think the subject of fac-simile telegraphy, referred to in the paper, is a most interesting one, and one which ought to be discussed. I think it is the last possible step in telegraphy to transmit a person's actual handwriting, and I feel that there must be some latent information in the Society on the subject which ought to be brought forward.

Mr. G. A. **Hamilton**: This is so much of a subject, and it is now getting so late, that it would be better to defer the discussion until another meeting and let the members have an opportunity meantime to familiarize themselves with the paper.

The **Chairman**: I am afraid, Mr. Hamilton, if we do, that some other paper will come up, and we shall all have to be satisfied with the plain record of this paper. I think, if we could talk about this now, it would be advantageous, because the discussion goes on record and will be scattered broadcast with the paper itself.

Mr. R. W. **Pope**: What particular advantage has this system in practical use?

Mr. **Hamilton**: I fancy it is to get greater speed. Hitherto the fac-simile systems have been so slow in practice as to be of no account commercially speaking. As we have not had all the details of the paper, I do not see how we can very well discuss it intelligently.

Mr. **Roberts**: I would like to ask Mr. Pope, if the fac-similes which he told us he saw were in large coarse handwriting, or whether the writing was small, and if it was small, was it so legible as to be easily recognizable.

Mr. F. L. **Pope**: The specimen I saw was quite a large and coarse writing. I should say the letters were a quarter of an inch high; but at the same time it was sufficiently distinctive, so that it could be recognized in most cases. While we are upon this subject—a gentleman has just asked what the advantage of the fac-simile telegraph is, and it must be said that the advantages of it, if there are any, lie in a very different direction from what most persons would be likely to suppose. It has always been taken for granted, by those not familiar with the details of telegraphic service, that if all communications could be sent in the actual handwriting of their author, there would be some particular and very important advantage in it. As a matter of fact there is no advantage whatever in it. I was shown a few years since, in France, the Caselli telegraph, working between Paris and Marseilles, and working very beautifully too. Fine close handwriting, such as you would put on a postal card, was transmitted with reasonable rapidity and with very great perfection. I was informed by the officers of the telegraphic administration that they had had it in use for some years on that particular line, for the reason that there was a great deal of financial business transacted between Paris and Marseilles, in the way of drafts and messages relating to the payment of large sums of money, and it was thought it might be very important, if on that particular line the message could be delivered when required in the handwriting of the sender. But I was told that practically it was very little used, except as a matter of curiosity; that when people had financial messages to send they preferred, for the most part, to send them in cipher in the ordinary way.

There is, however, another aspect of the subject, which is perhaps less apparent at first, and that is this: If it were possible to construct a purely mechanical fac-simile system, by which the original message, as the customer writes it at the counter, is thrown immediately into a hopper as it were, and not otherwise touched by human hands, while its fac-simile is ground out at the other end of the line ready to put in an envelope and sent to the correspondent, we should have a practical solution of the much discussed problem of "cheap telegraphy." It is certainly in that direction that we are to look for the solution, if it is to come at all. When I say "cheap telegraphy," I mean a system which is as rapid as the Morse system and as cheap as the Post Office, and that, I think, is the real point of interest in connection with autographic electric transmission. I regard all these attempts to realize fac-simile telegraphy in practice as so many steps in the direction of that universal telegraph which some of us may live to see, in which the work of transmission and reception will be purely mechanical, and the only skilled service needed will be that of the electricians and engineers who keep the apparatus and lines in order and look after their proper working.

Mr. Martin:—I had a specimen of Mr. Delany's work in my possession which purported to be a portrait. I would like to ask whether that system could be so materially improved as to send the portrait, say of Maxwell the alleged murderer, from St. Louis to San Francisco, or even under the sea to distant lands. I mean in such shape as the outline portraits in the daily journals not the gross libels, but the more accurate and artistic ones.

Mr. F. L. Pope:—I see no reason to doubt its perfect practicability. This Caselli system would certainly send good outline drawing in better shape than those we see in the daily journals. Although Mr. Delany's specimens are perhaps as yet, not quite up to that pitch of perfection, still I can see nothing in the system which would necessarily prevent it from being made to do as good work as the Caselli system. I have no doubt that it is merely a matter of the perfection of the apparatus.

Mr. R. W. Pope:—This question of recognizing handwriting is perhaps carried to a greater extreme than most persons are aware. At one time—I do not know whether it is the case now—there were banks in this city that would not accept checks where the signatures were written with a stylographic pen, on the ground that the character of the handwriting was determined mostly by the shading and hence they could not judge properly of the authenticity of the signature without the shading. Until we can reach a greater refinement in fac-simile telegraphing than has yet been done, I do not think that point is of any particular value. I do not think some of the messages which are handed in over the counter from day to day could be read by the recipient, unless they had first been translated by an operator who was an expert in handwriting.

Mr. F. L. Pope:—I agree entirely with what the gentleman has said. I have had some experience in that line myself.

Mr. Hazard:—You think you would not have gained anything if Prof. Houston had telegraphed his paper to you by the Delany system.

Mr. F. L. Pope:—If he had telegraphed it to me by the Morse system, and not by the fac-simile system, I think I should have gained a great deal.

The Chairman:—It is suggested that it would be far more convenient and acceptable to the members generally, if the papers that have been read here to-day, together with the discussion upon each, be mailed to the members separately as soon as they have been revised and printed, so that you get one paper within a few weeks and another within a week or two afterwards, and so on, instead of waiting until the volume is ready. This can hardly fail to be more satisfactory to everybody. It seems to the chair a very good plan, and I would suggest that unless there is objection to it, it should be followed.

Mr. Hamilton:—I think the council considered that at one time, and favored it.

Mr. **Martin**:—I had the preparation of the first volume in my hands, and had considerable trouble in getting the proofs back from the members. That is the reason why the pages are not numbered consecutively. Now, if the papers are taken in the order of their presentation here to-day, and the discussion is written out and each paper sent out as it is proof-read, the members will at least have something to keep the society in their mind, The pages will be numbered consecutively and then, if it is desired complete bound volumes can be issued by the Secretary.

Mr. F. L. **Pope**:—There is apparently no objection to that, except the slightly increased expense, which is probably not worth taking into account.

The **Chairman**:—Let me call your attention to the programme for to-day. We have had discussions here to-day upon the following subjects:—Protection of Electrical Invention, Patent Law, Mine Lighting by Electricity, Arc Lamp Mechanism, Underground Electric Light Wires, Lightning Rods, Secondary Batteries, Incandescent Lighting by Central Stations and Isolated Plants, cost of Gas and Electricity, and Fac-Simile Telegraphy. It seems to me that this is a very good programme and that we have really done an excellent day's work. I believe it will make a good showing for us, and one that we need not be ashamed of in future years.

Mr. **Martin**:—Before the meeting adjourns, I move that a vote of thanks be tendered to Mr. Jannus for the able manner in which he has presided over the session this afternoon.

Agreed to.

The meeting then adjourned.

Read before the American Institute of Electrical Engineers, May 20, 1885.

THE PROTECTION OF ELECTRICAL INVENTIONS.

BY FRANKLAND JANNUS.

It having been suggested that a few words on the above subject may be of interest, the following brief outline of the bearing of recent decisions upon patent interests is submitted, together with such comments and remarks as seem necessary to indicate their apparent application and importance.

The tendency of invention at the present time is toward improvement in the details of the great inventions that have brought the science of electricity so rapidly, prominently, and no doubt permanently, to the notice of the unthinking, as well as thinking, people of the civilized world.

As matters stand to-day, the dynamo, the arc and incandescent lamp and devices for regulating and controlling them, the telephone and its accessories, the motor, and the electric locomotive, inventions which form the foundation stones of the great systems of the future; these, in addition to the thousand and one minor applications which are a constant source of wonder to the general public, and sometimes of amusement to the skilled electrician, seem to supply every want, and render further efforts at improvement unnecessary and unprofitable; but it has seemed so from time immemorial, and our opportunities are at least as good as those of our predecessors.

Our laws give the inventor time for public trial and experiment within which to ascertain the practical utility of his improvements, and during which he usually has ample opportunity to discover their marketable value, before expending much time or money thereon.

The history of the Patent Office shows that during the last five years most of the patents granted on electrical inventions have been for improvements upon well-known apparatus. Were this not the case, that department might as well close its doors, for it hardly ever happens that a new system is perfect in its inception, and a single novel and operative device is frequently the subject of a long list of patents.

I take it for granted that you are aware how the Supreme Court has almost stopped the reissuing of letters patent by deciding that where the claims of a reissue cover more, or are broader than the claims of the original patent, they are void, because for another invention.

The cure has been so radical, and the reaction so strong, that reissued patents are now looked upon unfavorably, no matter what the reason for the reissue, so that the safest way is to get your patent out in good shape at first, and then stand or fall by it.

The Patent Office is responsible to nobody and guarantees nothing. The unpleasant fact that patents are so often declared invalid by the courts is a warning to inventors that they must see to it before letting a case go to issue, and be governed by decisions, and if necessary, insist upon what they ought to have, *before accepting* the patent, for after that it is too late.

The status of patents for improvements in the details of previously patented devices is generally as follows: The pioneer case, having been properly handled, should contain claims broad enough to cover all obvious changes, equivalents, and modifications and such claims are generally broad enough to cover important improvements as well, and the question is, what value can a subsequent patent have? Being subordinate to the original, the patentee would not be at liberty to manufacture the article covered thereby by simply adding his improvements to it, nor would his improvements give him title to his predecessor's productions, except of course as to old and well-known elements. For example, an improvement in holders for commutator brushes, or in the commutator itself, would not affect some other person's patented armature, nor an improvement in filaments for incandescent lamps, a method of sealing the same into the globe.

The practice in the Patent Office is supposed to be in accordance with the latest decisions of the courts in patent causes, and it is much more nearly so to-day than in years gone by. We can therefore best form an opinion of what a patent should contain by considering some of those decisions.

A long line of decisions has been rendered by the Supreme Court of the United States in patent cases, and these decisions cover almost every form of question, but they often involve propositions not to be found in the case under consideration, and the latest cases are always looked to and depended upon for a statement of the law as it exists. Some of the recent decisions having a special bearing upon the most numerous class of patents, namely, those for combinations of old elements to produce new or seemingly new results, I will bring to your attention the three most recent decisions, which were published only last month, my object being to explain what may be, and usually is, covered by a patent for improvement on some other invention, and also what is covered by a combination claim, in order to convey a fair idea of the scope of such a patent, and the rights and privileges of a patentee under such circumstances.

In the case of *Stephenson* vs. *the Brooklyn Cross-Town Railroad Company*, suit was brought for the alleged infringement of three patents, the first one for the combination of mechanism used by the driver for opening the rear door of a bob-tail street car. The court said "as there is no evidence of invention prior to the date of the application, and as the state of the art at that time shows that neither the separate elements of the devices nor the combination is new, it is held that there is no patentable invention in the contrivance described in the patent, and hence no infringement." (There may have been some novel construction embodied in this case which justified the Patent Office in granting a limited claim therefor which would probably have been held to be good, as far as it went; but there was evidently an attempt to use the patent for more than it was worth by the party bringing suit and it was therefore held to be invalid.)

The second patent was for two bell-cords provided with a system of pull-straps passing along the sides of the street car within convenient reach of the seated passengers, for signalling purposes. "As the evidence shows that long prior to the application such signalling appliances had been attached to the middle of street car ceilings, there was no invention in changing them to the sides of the cars, and hence the patent is void."

The third patent was for a combination of a bonnet, in which was fixed a mirror and an opening in the front door of a street car, by means of which the driver can see what is transpiring within the car without turning his head. "As each element is old, and as neither element performs any new office or imparts any new power to the other, and as all combined do not produce any new result or any old result more cheaply or otherwise more advantageously, this is a mere aggregation and not a patentable combination."

This entire decision is extremely important, and will be much referred to in the future, for the reason that it deals with questions arising every day, and states the proposition involved, more fully,clearly, and conclusively, than anything heretofore published.

In the case of *Sargent* vs. *The Hall Safe and Lock Company et. al.*, suit was brought to restrain alleged infringement of letters patent the claims of which were for combinations of mechanical elements. The defendants claimed that they did not infringe, because they did not use the combinations of elements mentioned in the patent. The Court considered the patent upon its face, and then considered the references upon which the application had been several times rejected. Then they took notice of the many amendments and persistent efforts required to secure an allowance, and decided that "in patents for combinations of mechanisms, limitations and provisos imposed by the inventor, especially such as were injected into an application for the purpose of securing an allowance after it had been persistently rejected, must be strictly construed against the inventor and in the favor of the public, and looked upon as in the nature of disclaimers, and further, that the mechanism of the defendant's lock not being the same as that covered by the patent, there was no infringement."

The court did not say that the patent was bad, but simply that in view of the state of the art at the time the patent was granted, with which every inventor is presumed to be familiar, he claimed more than he was the first inventor of, and that while it was perfectly good for what was novel, they did not propose to assist him to recover more than he was really entitled to.

The cases just cited refer to mechanical devices, and you might naturally ask, How does the court regard the combination of electrical elements? The following will throw some light on that question.

In *The Electrical Railroad Signal Company* vs. *the Hall Railway Signal Company*, also published last month, and which was a suit for infringement, it was held that defendants did not infringe, because the claims being for combinations of elements, they not having used the entire combination or substantial equivalents therefor, that they had not rendered themselves liable. The substance of the decision is as follows:

"The patent is for a combination in which the elements were known and open to the public use. Its object was the accomplishment of a particular result, namely, to work electric signals on the block system. But the thing patented was the particular means devised by the inventor to accomplish that result, and to constitute in this case identity of invention, and therefore infringment, the result, the elements or their equivalents, and the combination, must be the same, so that each element shall perform the same function.

"In complainant's patent insulated sections of the rails as circuit-closers constitute an essential element in the combinations, the wheels and axles of the train forming an electrical connection between the opposite insulated rails at appropriate places, and so actuating the signal. The defendants dispense with insulated sections of the track, and employ a separate instrument placed near the track, from which the lever connects with the track, and is operated by the passing wheels of the train.

"In complainant's patent, a single battery is used to operate an electric circuit of considerable length by means of two wires or other metallic conductors attached to the positive and negative poles of the battery, and suitably insulated from each other and from the earth. The defendant's plan does not include such a metallic circuit, but uses a circuit composed in part of the earth. In this case the evidence shows the difference is more than a mere substitution of earth for one of the conducting wires. It consists in the use of new elements, a new combination, and a new result."

From the foregoing it will be seen that the legal construction of combination claims is comparatively strict, on the theory that all the inventor has done is to assemble well-known elements in a manner different from his predecessors. He cannot acquire title to those elements except in his particular combination, and any other person is at liberty to combine a greater or smaller number of the same elements, if by so doing they do not attain the same result in practically the same manner. When, however, the invention consists in some new thing having an existence separate from a group of well known elements, then the case is entirely different, and the inventor is entitled to, and the patent should contain, a claim for the thing itself. If the single element is designed to form part of a group, the patent should also contain claims for the combination, and such claim, would, like any other combination claim, be evaded by the omission of any essential portion of the combination, but the element covered by separate claim cannot be used singly or in combination, without liability to the patentee.

Devices may be constructed in which the element is included, and combination claims including said single element may be presented, and the Patent Office, if unable to meet the combination with references, would be obliged to allow them, but that does not give the patentee of the combination any exclusive title to the element invented and patented by another; it only gives him title to *his* combination, as against any other similar "combiner" while he himself will have to secure license from the inventor before he may lawfully use that particular portion of his combination.

This, you see, leaves a clearly defined and very large field for the inventor of the present day, for where there is actual novelty, more than mere combination of old devices, such claims can always be obtained as will afford complete protection. One difficulty to be overcome is that of knowing at the time the patent is taken out all the modifications and adaptations of which the invention is capable. There are many cases in which, with the best intentions on the part of all concerned, patents have been less comprehensive than they might have been, and it seems that the only way for an inventor to secure the fullest protection is to consider all the separate and distinct practical applications of his central idea and patent them all, for in this country the cost of a patent is really very small as compared to the privileges granted, and there are no further expenses after the patent has issued, as there are in other countries, where periodical taxes must be paid and conditions as to manufacture complied with, in order to keep a patent alive.

Taken as a whole, I think that our patent system is really as wonderful as our system of government, like which, while offering the greatest prizes to any man whose genius, industry and diligence enable him to secure them, yet the acquisition and the enjoyment depend almost entirely upon the individual.

The law assures the full enjoyment of privileges acquired, but guarantees nothing until the individual has, by proper proceeding, perfected his title to the thing desired.

That thousands of worthless patents are granted every year is not the fault of the Patent Office, but is due almost entirely to the insistance of unscrupulous attorneys whose fees are staked upon the procuring of a patent, whether worthless or not, being frequently a matter of indifference to them, and sometimes upon the demands of clients who are impervious to advice or criticism, until, as the possessors of useless patents, their ambition dies a natural death. There are, too, cases in which a patent that would not stand the test of a suit is really of advantage to the inventor, but the first-named cause is by far the most common.

An idea seems to be entertained by many that the less a person is hampered by knowledge of a particular art the better his chances of being original, and the more likely he is to strike into a new line, and to capture a grand idea which, when harnessed and put to work, will develop into a tidal wave of prosperity, like the winning ticket in a lottery. Observation has shown that such inventors will rarely consent to a preliminary examination at any price, and that they are the most ready to assert that the examiner has failed to comprehend their invention.

The examiners are, as a class, exceedingly capable, but one thing should be remembered, which is, that they do not occupy the position of critics, and while it is often apparent to them that an application might be advantageously altered or more fully developed, still they can only act upon what is before them; they have nothing to do with what might be. That is mere speculation, and they are not in the position of investigators; they are simply there to deal with what *is*, and knowing more or less about all the patents in their particular class, an invention appears smaller to them than to a person unacquainted with the state of the art.

When it is remembered that, as a part of the result of the labors of these gentlemen, thousands of old and often absurd ideas are every year consigned to oblivion, instead of being spread upon the record, and that on reading the claims of a patent, if there is nothing more in it than some trifling combination, that fact at least will be at once apparent, thus saving the public in general much trouble and expense, the beauty and advantages of our system as compared with the systems of other nations, and the way in which our laws contrive to offer the maximum encouragement at the minimum public expense, will be better appreciated.

DISCUSSION.

MR. FRANK L. POPE:—I do not know that I can add very much to what Mr. Jannus has so ably stated in his paper. The remarks which he makes in reference to the examiners in the Patent Office are very proper. Those gentlemen are subjected to much unjust criticism. I have practiced before them more or less for some fifteen years. I have almost invariably found them courteous, careful and honest in their work. They labor under the disadvantage of having so much work thrust upon them, so much to be done with an insufficient force, and an insufficiently paid force, that to every one familiar with the circumstances, as most of our solicitors and practitioners are, the only wonder is how the work is done as well and with as few mistakes, and as little injustice as is the case. We all feel that there might be a great many improvements made in the management of matters at the Patent Office; but the difficulty is in the lack of adequate legislation, not in the character of the examining force, for this is better than we might have any reason to expect we could get for the salaries which the government affords. Examiners are obliged to pass over many cases with an insufficient examination; to allow many patents which they feel certain contain nothing of novelty, and of which if they were allowed sufficient time they could undoubtedly find an anticipation. We often hear it said of patents which have no originality in them, that if they are good for nothing they will do nobody any harm; but as a matter of fact they are often taken up by unscrupulous speculators, and used to levy tribute upon deserving inventors who have worked out something of real value which they are endeavoring to bring before the public. A worthless patent, which apparently on its face covers the whole matter, is bought up and very often capitalists are thereby discouraged from aiding the real inventor. I think that the general subject is worthy of more attention than it has received, and that those who are disposed to criticise our patent system should be careful to examine the matter and see that their criticisms fall in the right place, which is really upon Congress.

Mr. E. P. THOMPSON:—There was one point in Mr. Jannus' paper in regard to modifications of inventions which I should like to refer to. A man strikes a good idea. He wants to get it patented. He finds that he cannot get an idea patented. Then he makes a rough sketch of it. He is told that that won't do. He goes to work, and at the expense of a good deal of mechanical genius, perhaps, tries to get up a working device, and then he finds that it will not work. Some other man comes along who takes up the idea. He makes a model that does work. The first thing, then, is the invention—the principal invention. After the first inventor has taken out a patent, scores of other inventors come along and take out patents on about the same thing. They are patents on the modifications. Now I think that the very best way in which an inventor can protect himself is to make as many modifications of his invention as possible before he proceeds to apply for a patent. For some time past I have thought on the subject as to whether there are any rules that an inventor may follow in order to make the modifications of a particular invention, say, for instance, the telephone. When that first came out it involved the principle of producing an undulatory current by means of a transmitter. The first inventor made one or two modifications to illustrate his invention. But why didn't he go to work and make twenty or thirty modifications? How is the inventor to go to work to produce the modifications? Let him study his invention and see what action is to be produced. One principle to be applied is to vary the resistance of the current. One way to do that is to vary the length of the conductor. That conductor may be a solid, a liquid, or a gas. Let him get up all the devices by which he can vary the length of a solid conductor; get up all the devices by which he can vary the temperature of a solid conductor; get up all the devices by which he can vary the density of a solid conductor; get up all the devices by which he can make or break the different parts of a solid conductor. Then he goes to the liquids and gets up all the modifications relating to liquids, and even goes so far as to introduce the principle of electrolytes and electrodes, varying in the size of the elctrodes, varying the heat produced in the electrolyte, which will, of course vary the resistance; varying all of these different things combined. Then he may go to work with the gas and vary the resistance of a gas raised to a higher temperature in a vacuum, or between the electrodes of a condenser, and then he combines a solid and a liquid so as to vary the resistance. All these modifications will produce the transmitter; and it seems to me that there are laws, principles and rules which exist, but have not been thoroughly worked out, whereby a person, having made an important invention, can follow these rules so as to make all the modifications, and in that way he will be better protected than by any law of the United States Patent Office.

Mr. F. L. Pope:—I would say in reference to the remarks of Mr. Thompson that in my experience with inventors, which has been considerable, I find that with very few exceptions their minds are apt to run in a groove. They make a particular invention, and then try to follow the advice Mr. Thompson has given us, and think of as many modifications of it as possible. I have known instances of their getting twenty or thirty modifications, and yet when you come to analyze these you will find they have more or less affinity to each other. They all have a certain relationship and resemblance. A man having a different order of mind is attracted to the subject, and he takes it from an entirely different point of view. He works out an entirely new set of adaptations of the same fundamental idea, producing the same result, but utterly unlike anything the first man could ever possibly have thought of. Take the instance of the telephone which Mr. Thompson alluded to. Professor Bell, in his invention of the telephone, produced his undulatory current by vibrating an armature in front of the pole of a magnet and thus inducing a magneto-current. Of course, he saw that that was not the only way of producing an undulatory current, and he said in his patent that it might be done in various ways, as by vibrating the two parts of the conductor in an imperfectly conducting liquid, and by vibrating the plates of the battery and various other methods, but he suggested no practical way of working on that plan. A host of other experimenters and inventors went to work on it, and among them they discovered that carbon was the substance that would do it best. That was discovered by experimentation, not by reasoning; perhaps by reasoning and then trying; but it is a rusult that certainly would have been difficult to get at by the particular process of reasoning which Mr. Thompson suggests. At the same time it is very clear that his method would in many classes of inventions serve to cover the whole ground. I merely mention the case of the telephone as one in which I hardly think the complete and perfected result would have been brought about in the mind of one single person.

Mr. Jannus:—I would like to interject a remark or two myself. In preparing this paper, of course, it has been impossible to go into the details of any one particular branch; but I think that the subject of modifications is fully as important as anything else that the attorney or the inventor has to consider. Now, it very often happens that an inventor will embody his idea in a device. He will have an application prepared and probably receive his patent, and some time afterward he will discover that somebody is trying to evade his patent, and has done something that he might just as well have done himself, and that by reason of carelessness or an insufficient appreciation of the contract that he was entering into with the public, he had not done it himself, or stated that he contemplated doing so, and how; and then is the time the inventor tries to make his attorney responsible for anything that is left out, or rather might have been included, if the inventor had given the matter careful attention when the application was being prepared. I have a case in mind at the present time, in which the papers were sent to the attorney three times by the inventor and three times returned to the inventor by the attorney. Each time the attorney told the inventor: "You have shown so much and you have suggested so much more; now you have got to do your own inventing. If you choose to bring that in, give us a sketch; if not, understand that it is going to be left out." Finally the case went into the office after a third revision, and was allowed without an objection. There was something entirely new about it. There was such a difference between the first and second and third sheets of those drawings that they could each one have been separately patented if they had been presented by three separate men and specifically claimed. That is why I think that special prominence ought always to be given to that branch of the subject.

Mr. T. D. Stetson:—I labor under the disadvantage of not having heard all the paper, but the matter has been referred to since so clearly that I can say something in regard to the matter of modification. The history given by the gentleman who read the paper of the case going backward and forward several times is an interesting one. That inventor was fortunate in having an agent who took that amount of pains, and the agent was fortunate in having a client who complied with his wishes so promptly. It was a case of a good job due to both of them. In many cases the inventor is so anxious to cover all the ground that he does not give a specific and exact description of anything. One of the things we want to do in all these cases is to make one specific description, and, by rights, perhaps, it ought to be the best form, but that doesn't matter so much. You may select the simplest one; or sometimes I am fond of selecting the most complex, the most *outre*, the most *bizarre*, the one that has the most heads and horns to it. I have a kind of sterreotyped form of expression that I work into almost all specifications saying that modifications may be made in nearly all points without sacrificing the advantages of the invention, and then go on and enumerate a few. In this matter of modifications sometimes this state of things arises which is of interest—the main, bottom principle has already been covered by some absurd thing which would not work, and we find the art already advanced to such a stage that we cannot make the broad, sweeping claim we want to. In fact, it almost always seems so, and we have got nothing left but modification, though there will be modifications of the modifications, and so on. In one case I had a steam pump matter—a pulsometer. The bottom thing had been done by somebody who made a poor one. Then came a man who made a sensible one, the one that has been used all over the world—Hall. Mr. Pope has explained very nicely how there will generally be a family relationship with these different things if they all come from the same man. But a man that is ingenious can make a good lot of modifications. I was the agent who probably ever took out the most patents on one thing on the same day—twenty-nine. On the 30th of May, 1882, twenty-nine patents were issued to one man on a matter of steam pumps, and the man tried with considerable success to cover all the modifications that could be made that were good for anything, except the one that had been specifically stated in the original man's patent. Now if the original patent has got a particular claim, and that claim was drawn by skillful hands, and if the proper amount of help had been given by the inventor to the attorney and the proper amount of help back again, the original claim ought to have been big enough to cover them all.

We have changed the law and the practice a good deal with regard to obtaining reissues. When the modifications had been made by other people or by ourselves, we would go to work and reissue our patents. The Supreme Court has put an end to that. In a series of cases they have decided that if a man has got his patent wrong he ought to find it out right away. It has been intimated in some of the decisions that two years is enough. Practically we might say that the man ought to find it out within two years and apply for his reissue. It amounts to this, that for two years the inventor has the privilege of monopolizing all the improvements that come up after it. Some foreign countries provide for that formally by law. Austria tries to give nobody else a patent for a modification, or branch, or ramification, or improvement on the original idea, for a year—a nice thing in practice. We have got something like it that gives the inventor two years, which is better yet.

Mr. F. L. Pope:—I should like to call the attention of Mr. Stetson to one of the decisions referred to by Mr. Jannus, a recent decision of the Supreme Court, and I hope I may be pardoned for mentioning it, as the suit arose on a patent of my own for which I drew the specification myself. It was on this very question of modifications. It was the case of the railway signal, The patent was for a particular system of circuits for operating signals automatically by the movement of a train along the line of the road. Now everything about the general system was old. There had been innumerable forms of signals worked by electro-magnets and batteries, and having the circuits closed in some manner by the train moving along the track; the idea being that as the train progressed from one signal station to another, the signals would be exhibited in orderly succession behind the train, and the track thus be kept blocked in the face of a succeeding train. The most common plan had been to have one signal for each section, with its own battery, its own circuit-closer, and its own separate electric circuit. The improvement which was intended to be patented was a system of circuits by which one battery was made to do the work of the several individual batteries which had before been scattered all along the road. This battery was placed at some convenient point and two battery wires were carried along the road, and the circuit-closers, signals, and the like were connected with them, so that any particular signal was operated through those wires. Now the form of circuit-closer described in the patent, which was a very old one, was a short section of insulated track-rails brought into connection with each other through the locomotive, which served to close the circuit and operate the proper signal. That was one form of circuit-closer that had been long in use; and of course there were other forms, equally well known, in which a pedal was depressed by the wheel of the train, being fitted with a key at the other end. Another method was to put a circuit-closer underneath the rail, where the deflection of the rail would press the circuit closer down, and in that way operate the signal. All these devices were very old, and there were probably anywhere from ten to fifty of each kind. Now the patent expressly stated in its specification that it was not confined to any particular species of circuit-closer. The patent said the circuit might be closed by a hand circuit-closer, for that matter. The novelty consisted in the specific arrangement of *circuits* to work all the signals from one battery. But the Supreme Court held that because the defendants did not use the particular kind of circuit-closer, that is an insulated rail (instead of which they used a key which was operated by the depression of a lever by the wheel,) they did not infringe. Now that might have been true if that method of closing the circuit had never been known before; but in fact it was the oldest form in existence. So that we see in that case the description of the preferred form and the statement that other well-known forms might be used in place of it, did not answer the purpose.

Mr. Thompson:—I do not know exactly whether I made the main point clear about these modifications; but it seems clear to me, and I want to make it clear to you. In any department that you take up, you find the rules, the laws that exist, and after they are discovered they are applied. A long time ago perhaps not more than one man out of a million would have been able to paint a picture that looked like the object it was intended to represent. As time went by somebody noticed that when you look at an object at a distance it has a certain appearance, and in order to represent that on the canvas, it is not necessary to go into all the details just as they appear to the eye; but there are certain optical deceptions which you must reproduce. It is not necessary to go through all the different departments; but it is the same, I think, in a great many departments where rules are established, and men learn to become artists or professors in any department by studying these rules and the principles underlying the rules. Now that method has not come to perfection yet in the department of invention; the process of invention has not yet become a science. The examiners sometimes say that a thing shows no "inventive genius." To me the term "inventive genius" has no meaning when used in reference to derived inventions or modifications. For instance, I say to a man: "Here is a carbon filament shaped like a figure 8; if you make that carbon filament in a different shape you can get a patent on it." Now the man who makes it in another shape may not have any inventive genius. During the past year two patents have been granted, one on a kind of double figure 8 and another on a spiral—absolutely on the *form* of the carbon filament. Some people may say that is of no value. They do not know, until they really study the thing, whether the invention is valuable or not. So another man would go to work and make carbon filaments of all the geometrical forms you could think of. Now if the first inventor had the wit to get a patent on the form, he could have included all the forms imaginable. I speak of these things, seeing that there are several gentlemen here interested in this subject, both as inventors and as attorneys. When they see any invention come out, if inventors will notice what rule they can follow in order to apply that same principle of invention in some other department, the number of inventions will be multiplied, and by multiplying the number of inventions the progress of civilization is furthered.

Mr. F. L. Pope:—I do not wish for a moment to be thought to say anything in disparagement of Mr. Thompson's plan, for I think the systematic study of all these things is of the utmost value, and that inventors' work would be a thousand times better done if they would reduce their thoughts to some system and follow it out in a logical manner; but still I regard it as a mistake to suppose that any system of that kind carried out to however great perfection, would necessarily develop all that there is in any one line of invention. It seems to me that the matter of invention does not differ materially in that respect from painting pictures or composing music. Every artist does a great deal better work for having a systematic, thorough course of training in all the principles of the art. It is the same in music and it is the same way in many other things. But after all that is not the way in which great composers, great artists, and great inventors accomplish their work. It is most valuable assistance to them and most neccessary assistance, but still it is not everything; there is some inspiration beyond that. Mr. Thompson does not understand that there is such a thing as "genius" in these matters. I think there is a little. But, as I say, I heartily concur in everything he has said about the importance of systematic study, and I think Mr. Thompson is entitled to great credit for being the first one, so far as I know, to systematically develop such a plan of investigation. I believe the work which Mr. Thompson has done will be recognized in all future time as of very great importance; but, as I say, I don't think it quite covers the whole ground.

Mr. Thompson:—I wish to correct a misapprehension of what I said in regard to inventive genius. There is inventive genius, in my opinion, in the first conception, but in respect to the modifications of that invention I think the work can be followed out by rule.

Mr. E. P. Roberts:—If I want to get up any little thing I say to my man and he is one whom I can trust thoroughly, "I want to do so and so; you think it over, and put down on paper what you think about it." I put down on paper what I think of it. He shows his plan to me, and I show him mine already drawn out, and we compare them together, and they may both have points that may be worked together, and in that way we often cover points that neither of us would have thought of independently. I think inventors as a general thing are not trusting men. If they could trust other men and work together more than they do, I think it would be advantageous.

Mr. T. C. Martin:—It will be remembered by Mr. Jannus that at our meeting in May of last year a resolution was adopted, "That the chair appoint a committee of three, who shall take such action as they may deem proper, with a view to calling the special attention of Congress to the needs of the Patent Office, especially in regard to the class of electricity."

I may say that there was a good deal of contemplated patent legislation last year, and in view of that fact the Council held its hands. It appears that some action might properly be taken this year. As to the needs of the Patent Office in regard to electricity, I would like to call attention to a paragraph in our first volume of Transactions, from the valuable paper read by Mr. Kintner. He asks the question: "Now, gentlemen, what do you think of a bureau of scientific experts upon mechanical, electrical and chemical technics, without any mechanical workshop, without any electrical apparatus, and with a laboratory having a total valuation of less than $500." That statement has a very direct bearing on this question of protection of electrical inventions, and I think that the Society might strengthen the hands of the Council by asking them to put into force the resolution passed at the meeting last May. There is one point on which I would like to ask Mr. Jannus a question, relating to that same matter. Mr. Jannus here says: "The Patent Office is responsible to nobody and guarantees nothing." Are we to accept that, gentlemen, as it stands? Are the inventors to understand that? Are the patent lawyers of the country to understand it? There are now over six thousand electrical inventions patented in this country. It seems to me that the number is not likely to be very largely added to if it is to go on record without any modification or explanation that the Patent Office guarantees nothing and is responsible to nobody. It seems to me also it is not of much use for this Society to seek to bring about a reform of the Patent Office if it guarantees nothing and is responsible to nobody.

Mr. Jannus:—That is an exceedingly pertinent question, and I am glad that it has been asked. I say here that "the Patent Office is responsible to nobody and guarantees nothing." I stick to just exactly what I said there. The Patent Office is a sort of an investgating bureau to which an application is submitted, and the duties performed there are simply to examine that application, and if they can find anything to anticipate, to reject it on those references. After which the applicant may amend his claims, and when he gets his claims down to a point that is satisfactory to the bureau, the patent is issued. Of course, the courts are ultimately the tribunals before which the question is settled. If the Patent Office grants an inventor too much, it is cut down. If it grants too little, the courts have said, "You ought not to have accepted the patent; you ought to have insisted on more." It seems rather a bold statement to say it is responsible to nobody, and guarantees nothing, but it is literally true. Those gentlemen are there to act on what is before them. There is no penalty whatever for the failure, on the part of the examiner, to cite an exact reference, even if he has it in his portfolio. But there are many classes to-day in which the art is not thoroughly represented in the Patent Office, and consequently it is an impossibility for the examiner to know what has transpired. Patents are granted every day for things that are old, but the Patent Office does not know it. Now, what are their sources of information? Patents that have been granted, foreign patents, publications, and, in some instances, a few catalogues from leading manufacturers. I might suggest that, in the class of velocipedes, for example, the Patent Office is behind the time. I do not think that the examiner in that class has in his room, at the present day, well known catalogues that show ten times more than any patents that have ever been published, and you will easily see how it is possible for them to overlook pertinent references without intending to do so. If a patent is declared invalid to-morrow, the examiner does not suffer in any way. He is sorry, perhaps, but he does not suffer. There is no penalty attached. He does not lose his salary or his position; and I made that statement to call your attention to the fact that it is for the individual, through counsel, or by himself, to thoroughly investigate the matter, and be just as sure as he can make himself that what he gets he is entitled to; and that what he is entitled to has been put in the best possible form; because, if those two circumstances concur, the result is a patent that will be sustained by the courts to the end of its term, and which nothing can endanger; and it is only that sort of patent that is able to withstand the efforts of infringers.

The Chairman (Mr. SYDNEY F. SHELBOURNE):—I observe that Mr. Jannus uses the terms "responsible" and "guarantee" in their legal sense. It would be impossible to bring a suit against the Commissioner of Patents or the Examiner for making an error.

Mr. MARTIN:—That is exactly the point I wish to have explained. It might appear to the public that we had calmly accepted the statement that it was the case, and I would not like to have it go out in that way.

Mr. JANNUS:—I am sorry I did not answer the question; I thought I had, but it seems I did not. From the Commissioner down, the Patent Office officials are judicial officers. Their acts are those of discretion largely. They use their judgment and they decide. They are not responsible legally to any one; if they make a mistake you can bring no suit against them; you can recover nothing from them. There is, however, one method providing for rectifying mistakes as soon as may be, which is this: If a patent has been granted to the wrong person, and the right person comes in subsequently and makes the fact apparent to the Patent Office, they will grant him a patent also, so that while they cannot cancel a patent once granted, they will grant a second one, and it is expected and assumed that the evidence brought forward to justify them in granting the second patent will be sufficient to substantiate the right of the latter applicant. But the final decision of the question goes before the court, and is there decided, and there only.

Mr. POPE:—I would like to ask Mr. Jannus whether some measures have not been taken within the last year, looking to the procuring of a laboratory for the Patent Office? I had some conversation with the late Commissioner, Mr. Marble, at one time within the past year, and I gathered from what he said that some movement was on foot which would probably result in the providing of a considerable amount of apparatus for the use of the Office. Perhaps Mr. Jannus can tell us if anything has been done which might render action on our part, with regard to this resolution, superfluous.

Mr. JANNUS:—There has been discussion on the subject. It has been considerably agitated; but as a matter of fact, the Patent Office is almost in the same condition as it was before, so far as we are concerned. There is no chemical or electrical laboratory there at all. There have been a few incandescent lamps put into the building, and of course the apparatus necessary to operate them is accessible for the instruction of the new men. That is all. The Commissioner, however, has had his attention called to it. Mr. Kintner has made continued efforts in that direction, and it is really hoped that the next Congress will do something about it.

I think that a memorial or some such step might be taken to call the attention of the Committee on Patents to the subject, which would be of some advantage. They propose to have a building. They have plans of a shed to use as a laboratory, but nothing whatever has been done.

The Chairman:—At our last meeting the following resolution was passed: "Resolved, that the Chair appoint a committee of three, who shall take such action as they may deem proper, with a view to calling the special attention to Congress of the needs of the Patent Office, especially in regard to the class of electricity." It does not appear that that committee was appointed, and if some member will offer some motion with reference to taking action on that subject, it may be referred to the Council and assume shape and activity from that source.

Mr. Jannus:—To bring the question before the meeting I move that the matter be referred to the Council, with the suggestion that they appoint a committee to present the matter to Congress in such form as may seem to them best. Motion carried.

A paper read before the American Institute of Electrical Engineers, May 20, 1885.

COST OF MINE LIGHTING.

BY F. P. MILLS, STAMBAUGH, MICH.

THE plant was set up and running at the Cleveland iron mine Ishpeming, Mich., May 10th, 1880.

The machine employed was a No. 7 Brush dynamo, with old style armature core, and lights of 2,000 candle power each.

For the underground workings was used a so-called dye house, single carbon lamp. The connections across the top of the lamp being filled in with tar; rubber gaskets being placed between the case and side plates. The surface lamps were of the ordinary double carbon pattern.

The dynamo on stone foundation, topped with a shellacked hard wood plank, was placed in their No. 1 engine house; and three distinct loops, all of No. 8 copper wire, were run from there.

The number one circuit comprised all the lamps underground in No. 3 pit, and was about 3,000 feet long.

Number two circuit took in all the lamps on surface, they being placed at the various pockets and engine houses, and was about 4,600 feet long; while number three circuit ran into the incline pit, a distance there and back to dynamo of 6,000 feet.

A continuous ringing bell, permanently connected to a Leclanché cup; and with an outside coil of heavy wire traversed by the light current, serves to call attention to a break in the line.

In such an event the broken wire was cut out by a short circuiting switch, one being connected with each loop, and thrown in again upon the repairs being made.

The wires were run wholly upon glass insulators. Underground, where the brackets could not be spiked to stull timbers or wooden pockets, they were run to some iron ore pillar, or to the walls of the pit; and where neither of these could be reached, the wires were suspended from the roof or hanging wall. When run to pillars, or walls of the pit, the brackets were bolted to an iron cramp, having a suitable number of iron cross arms.

A split end, fitted with a wedge, served to securely fasten the cramps in a hole drilled into the ore or rock. In the mine the lamps were suspended by a rope, running through a sheave attached to an eye cramp let into the roof. The other end of the rope was tied to any convenient piece of ore, rail or timber, as the case might be.

The lamps were always taken down out of the way at each blast, the switch-boards being pulled up close to the roof, to get them as much out of danger as possible, though this did not prevent them from being occasionally smashed.

The surface lamps were suspended in the usual way. The wires underground hung slack between the insulators, they proving less liable to be broken that way.

They could not, however, be prevented from being cut by the flying pieces of ore and rock in spite of all possible care, and every day a number of splices in each pit had to be made.

Lengths of wire would often have to be renewed entire, for the reason of their having been hit so many times, and containing so many splices.

There was used a 10 by 20 inch variable cut-off engine belted direct to the dynamo.

A stationary bricked-in boiler, 5 by 16 feet with 81 3-inch tubes, supplied the steam, the boiler being shut off from the hoisting engine and used only for lighting purposes.

Both wood and coal were used, though for each separate month it was all coal or all wood.

The engineer's time was not charged, as he could easily attend to the dynamo and engine while doing his other work, neither did the light stand the expense of firemen, as it cost no more to fire than when simply doing the hoisting, no extra wages being paid. The only labor cost was that of one man upon each shift, whose business it was to renew carbons, mend lamps, and keep the wires in repair. The plant worked 20 hours out of the 24 every day, except Sundays.

With wood at $2.50 per cord, it cost for fuel for the three months of September, October and November, in all 8,291 hours, an average of 3.0907 cents per hour per lamp, or .01233 cords of wood per hour per lamp. For December month, with soft coal carefully weighed and charged at $5.00 per ton, the 4,676 hours run cost 3.462 cents per hour per lamp, or 13.85 pounds of coal per hour per lamp. The above is simply the fuel cost, the complete cost, in detail, is as follows:

OPERATING EXPENSES.

MONTH OF DECEMBER, 1880.

Costs common to all Lamps.

LAMPS.	COAL.				OIL.				ATTENDANCE.		
	Tons.	Cost.	Per Hour per Lamp.		Gallons.	Cost.	Per Hour per Lamp.		Days	COST.	
			P'nds.	Cost.			Gallons.	Cost.		Am'nt.	Per Hour per Lamp.
All Lamps.	$32^{\underline{760}}$	161 90	13.85	.03462	12.	12 00	.00256	.00256	50	100 00	.03138

SPECIAL COSTS.

LOCATION OF LAMPS.	CARBONS.			COPPER WIRE.			ROPE.			SUPPLIES COST.	
	Number.	Per Hour per Lamp.			Per Hour per Lamp.			Per Hour per Lamp.		A'mt	Per Hour per Lamp.
		Inch.	Cost.	Feet.	Feet.	Cost.	Feet.	Feet.	Cost.		
No. 1 Engine House	75	1.8127	.01057								
No. 3 Dock - -	44	2.4082	.01404								
Incline Dock -	4	2.5263	.01473								
No. 3 Engine House	42	1.7439	.01017								
Total surface	165	1.9341	.01128							1 40	.00136
Incline Pit - -	335	2.0727	.01209	276	.14230	.00593	75	.03867	.00049	2 30	.00118
No. 3 Pit - -	348	2.4085	.01402	216	.12613	.00525	100	.05839	.00074	4 09	.00239
Grand total -	848	2.1638	.01262	492	.10522	.00438	175	.08742	.00048	7 79	.00166

RECAPITULATION.

LOCATION OF LAMPS.	LAMPS BURNING.		TIME.	TOTAL COST.	COST PER HOUR PER LAMP.		REMARKS.
	Day.	Night.	Hours. min.		without	with	
					Attendance.		
No. 1 Engine House	1	1	496.30	35.02	.04922	.07060	Price of Carbons .07 each. " Coal - 5.00 per ton " Oil - - 1.00 " gal. " Cop. Wire .50 " pd. " Rope - .16 " " " Supplies - at cost. " Attendance, $2.00 per day.
No. 3 Dock - -		1	219.15	16.21	.05263	.07402	
Incline Dock -			19	1.40	.05230	.07368	
No. 3 Engine House		1	289	20.27	.04875	.07014	
Total surface -	1	3	1,023.45	72.90	.04960	.07119	
Incline Pit - -	4	4	1,939.30	151.82	.05687	.07826	
No. 3 Pit - - -	5	5	1,712.30	138.72	.05964	.08108	
Grand total -	10	12	4,675.45	363.44	.05634	.07772	

The cost for four months, hours burning, and cost per hour per lamp is as follows:

OPERATING EXPENSES FOR FOUR MONTHS, ENDING DECEMBER, 1880.

MONTH OF	TIME.	COST.		REMARKS.
	hours, min.	Amount.	Per Hour per Lamp.	
September	1,668.10	122.86	.073657	This includes everything but the expense of firemen and engineers who attend to other work and do this without extra cost.
October	3,353.20	239.37	.071384	
November	3,270.20	251.81	.077000	
December	4,675.45	363.44	.077724	
Total	12,967.35	977.48	.075382	

It will be noticed, from these cost statements, that the consumption of carbons was greater in the exposed surface lamps, than in those in the engine houses, and but a little more than those underground.

The cost of lights, in the hoisting engine houses, was less than with kerosene, as with the latter one lamp would be put over each drum, in addition to lights for the engine.

Upon the docks there was no comparison with oil, as the electric lamp threw a light that enabled the cars to be readily handled, and of such assistance to the ore sorters in the way of showing the true colors, that they could not be dispensed with.

In the mine they were employed at all the big stopes, and especially where much filling or ore sorting was going on.

Although many miners' lamps had still to be used, it was considered economy, even at an additional expense, to run the lights to admit of a better supervision of the operations; more work done, and cleaner ore.

Another use to which the lamps were sometimes put, was to reverse them in the line, and examine the roof by the strong upward light thus thrown.

The plant is still running without material alteration, excepting the mine circuits, which have to be advanced as the work progresses.

Following are figures the chief engineer has just sent, showing their present fuel consumption, which indicates an improvement on the old run. With seven lamps burning, the engine indicated 11.73 horse power, with a consumption of 36.79 pounds water, and 4.9 pounds coal per horse power per hour. This is adding 20 per cent. of water shown for indicated horse power, by the card, for loss by condensation, and making a moderate allowance for boiler evaporation of 7.5 pounds water per pound of coal. This gives 1.675 horse power per light, and 8.211 pounds of coal per hour per lamp. With more lights, or a larger plant, the result would show still better on account of less friction, a longer cut-off, with a consequent higher effective pressure, and less condensation.

DISCUSSION.

The **Chairman**: Discussion on this paper is now in order. I presume there are gentlemen present who are experts in arc lighting. I will call upon Mr. E. P. Roberts to give us his views.

Mr. **Roberts**: I would like to ask what kind of coal. I heard $5.00 a ton for soft coal, and I thought I heard before that $2.50.

Mr. **Martin**: $2.50 for wood.

Mr. **Roberts**: Then I misunderstood. Does it say whether it is lump, slack, or what?

Mr. **Martin**: It says here: "Soft coal carefully weighed and charged at $5.00 per ton.

The **Chairman**: I suppose that Mr. Roberts is acquainted with the use of storage batteries for lighting?

Mr. **Roberts**: We have no mine lights at present.

Mr. **Martin**: There is one point there that seems to me to call for a little remark.—"They (the wires) could not, however, be prevented from being cut by the flying pieces of ore and rock in spite of all possible care, and every day a number of splices in each pit had to be made. Lengths of wire would often have to be renewed entire, for the reason of their having been hit so many times, and containing so many splices." If I may be permitted to refer to the *Electrical World* of January 24th, there was an article by Mr. C. E. Reynolds, who had done some lighting in tunneling in the Mantiqueira mountains in Brazil. He says with regard to the running of the wires through the mine: "The wires were fixed against the sides of the tunnel by wooden plugs driven into holes bored for them. At first these were simply laid along the tunnel without any covering, but I soon found that it would never do to leave them bare. The pieces of rock flying about from the frequent blasting soon made havoc both with the wires and with the lamps. Some means had to be devised to protect them. The wires I placed in a casing of thick boards right through the tunnel with a lid that could be easily opened when I wanted to get at the wires.

Mr. Roberts: The figure given as to the cost per hour—does that include repairs on wires, for it seemed to me pretty high?

Mr. Martin: The remark is, "This includes everything but the expense of firemen and engineers who attend to other work and do this without extra cost." It is a comprehensive cost statement, I take it. This paper, I might state, refers to arc lighting under ground. If any gentleman would favor us with remarks on incandescent lighting to the same purpose it would be interesting.

The Chairman: I assume that for incandescent lighting storage batteries may be in use. I am not aware that they are. I think, perhaps, the branch of the subject relating to storage batteries and incandescent lighting might be discussed to advantage, if there is anything to be said on that subject.

Mr. Thompson: Would not that subject come more properly under the head of the paper on storage batteries for commercial purposes?

The Chairman: Has Mr. J. F. Kelly any views on this subject?

Mr. Kelly: I have nothing to say that would interest the Society sir, in regard to that.

The Chairman: If there is nothing further to be said, the discussion on that paper is closed and the next paper will be read by Mr. Edward P. Thompson, mechanical engineer on the Electric Arc Lamp Frictional Clutch.

[illegible]

THE ELECTRIC ARC [illegible] CURVE.

[illegible]

The object of this paper [illegible] the first place [illegible]

The second object [illegible]

The [illegible]

Anyone making a [illegible] London in 1881 [illegible]

Read before the American Institute of Electrical Engineers, May 20, 1885.

THE ELECTRIC ARC LAMP FRICTIONAL CLUTCH.

BY EDWARD P. THOMPSON, M. E.

The object of this paper is two-fold—to bring before the society a new invention, of which the writer is not the inventor, for the purpose of soliciting from electricians their criticisms and opinions. The opinion of the writer, in the first place, obtained from his investigation of existing patents, of models of the lamp, and of the important modifications capable of being made, is that the patent is valid, the invention is ingenious, the device is simple, and the result is a non-vibrating movement of the electrode and an absence of dash-pots and other means of compensating for sudden variations of current.

The second object is to make the members have the same opinion. Assuming this to be a dfficult task, he desires, as follows, to make an analytical investigation of the development of the frictional clutch.

The well-known trick of a ball, and string passing through a crooked hole in the ball, whereby the loosening and tightening of the string cause the ball to fall and to stop respectively, operates upon the same principle as the frictional clutch, and the principle may therefore be defined as a clutch for a carbon holder, consisting of a device whereby a variation of pressure upon the carbon holder produces a variation of motion of the electrode. Any device falling under this definition is a frictional clutch.

Any one making a frictional clutch will infringe no one's patent so long as he makes a clutch different from any other clutch in every detail; for the patent granted to Slater & Watson, of London, in 1852, No. 212 (English), includes two superposed clutches which are simultaneously the armatures of electro-magnets, and through both of which the carbon holder freely falls when the armatures are horizontal, but ceases to move when the armatures are inclined, exactly in the manner of action of the ring clutch in the Brush lamp. The patent referred to, being dated thirty-three years ago, has expired. It is fully described in Dredge's "Electric Illumination," page 387, and in the appendix, page xxxvi., as a carbon holder passing through an eye in a lever actuated by an electro-magnet.

The above definition of a frictional clutch may be analyzed and considered as a problem for the purpose of arriving at the conditions to be fulfilled, when and where they should be fulfilled, and in what manner.

In the steam engine, variation of pressure was formerly obtained in the cylinder, and is at the present time, in some instances, by means of the movements of a throttle-valve located at a distance from the cylinder. In the improved forms of engines the device for varying the pressure is located in the cylinder itself, and the slide valve is employed both as a means of admitting the steam and as a means of regulating the amount admitted, and in all departments of industry it is advantageous to locate a regulating device as closely as possible to that which needs the regulation. Therefore, is it not necessary that in an arc lamp frictional clutch, all the regulation of pressure should take place at the carbon holder itself, and not by means of dash-pots, springs, etc., located at ends of levers which are endowed with the unremovable property of inertia and weight? Evidently it is preferable.

The variation of pressure in the electrodes of telephone transmitters all takes place, in the improved instruments, within the limits of constant and complete contact. Upon small variations of current in the case of the ordinary ring clutch, the ring and the carbon holders are not always in contact, especially if the variations of current are very great, and more especially if the dash-pot is not attached. The consequence is that the carbon holder falls a greater distance and with greater suddenness, and stops also with a greater suddenness than if the friction were not entirely removed.

Some have said that the unsteadiness of the arc lamp is due to the poor quality of the carbon; others, to the defects in the generator; others, to the cutting in and out of other arc lamps; others, to the poor construction of the system in general and others, to all these combined: while they seem to think that the clutch has reached its perfection and that there is nothing to be said against it: whereas, according to the definition, a clutch could certainly be made which would produce alternate darkness and brightness at almost any rate.

We may safely say that the steadiness depends upon the clutch more than upon anything else.

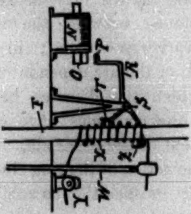
The intensity of the light and heat depends upon the length of the arc. Therefore, the intensity of the light due to incandescence of the electrodes and to their combustion depends upon the length of the arc.

The length of the arc depends upon the electromotive force, upon the shape of the electrodes, and upon the distance apart of the electrodes; or the arc may be kept constant in length by varying the distance between the electrodes every time the other named variables change; in short, the steadiness of the light or length of the arc depends upon the quickness and definiteness with which the distance between the electrodes changes after the other variables have changed, and upon the steadiness of movement of the electrodes.

Coming now to the action of the ring clutch and all its modified forms and adjuncts, let its operation be analyzed thus, with as little reference as possible to any other part of the lamp. When the ring is horizontal, the carrier of the carbon electrode is free to fall. When it is inclined at its maximum, the carrier is retained in a fixed position. At a certain point of inclination, the least increase or decrease of inclination will cause the carrier to fall or to be retained from falling. If the increment or decrement of inclination be infinitesimal, the carrier and clutch are still in contact, and the friction existing between the two surfaces diminishes the velocity as it tends to increase, and thereby gives the holder a uniform motion through an infinitesimal distance; but the increments and decrements of inclination of the ring are not infinitesimal, and therefore the ring and carrier are not in contact when the decrements of inclination occur, although the period of non-contact is very short. The consequence is that the velocity of the carrier increases as the square of the distance during the time that the ring and carrier are out of contact. To take the place of this lack of the retarding effect of friction, inventors have supplied a dash-pot whose piston is connected directly or indirectly with the ring. This is a help, undoubtedly, and its efficiency would be very marked were the individual movements of the carriers of any considerable degree; but as they are all within a distance of a very small fraction of an inch, such as a tenth or a hundredth, the piston scarcely acquires any motion at all, and especially not till after the carrier has been checked by an increment of inclination of the ring, on account of the inertia of the parts and lack of definite motion at the connecting joints.

As a means of closing doors noiselessly and in steam engines, the dash-pot is very desirable and effective for the purpose intended, and is adapted in all cases where any considerable extent of motion takes place; but for an arc lamp clutch it is theoretically and practically a non success.

Several patents have also been taken out involving a spring attached to the ring, so that the motion of the carrier would be retarded, when the ring is inclined. This may be called an improvement from some stand points, but the fact still remains that the carrier and ring, even with the spring attachment, do not remain in contact, and therefore the movements of the latter, being vibratory, the movements of the former are vibratory also, and not only vibratory, but jerky, as familiar to all versed in the art.



New Arc Lamp Clutch.

Waterhouse and Loomis have introduced further improvements by having two ring clutches, the former inventor supplying dash-pots and springs and locating the two rings at a distance from each other; while Loomis's patent locates the one ring upon the other with a spring between the two, the idea in each being to obtain a steadier motion by such an arrangement that the primary clutch is assisted by a secondary clutch, producing a combined and more effective result.

However, in all the improved forms thus far mentioned, and in numerous other patents acting on the principle of the ring clutch, the motion of the latter is abruptly intermittent and, therefore, that of the carrier is abruptly intermittent also. A clutch to be perfect, practically and theoretically, should operate to produce a continuous increase or decrease of pressure upon the carrier, and the piece producing this pressure should always be in contact with the carrier; *i. e.*, the pressure should never be zero, neither should it be so far diminished for maximum movements of the ring that the carrier has an accelerating motion.

We have before us a clutch invented by Mr. Jean A. Wetmore of this city. It combines within itself all the qualities and fulfills all the conditions required.

Its true value will be appreciated upon inspection of its construction and operation. As seen, it consists of a cylindrical coil spring through which passes the carbon carrier. By certain manipulations of the spring, the carrier may be regulated in its movements with the utmost nicety. If the spring is bent laterally, the carrier is lifted. If the spring is partially straightened again, the carrier is subjected to less pressure, and consequently its own weight causes it to move downward, not with an accelerated, but uniform motion, because the coil spring, tending to straighten itself, constantly presses against the carrier. It may be manipulated by the hand as easily as a ring clutch by electro-magnets, showing that its good results are not dependent upon the delicacy of action of the operating force. Accordingly, when operated by electro-magnets in the main and shunt circuits, the carrier is regulated so perfectly that the light is almost as steady as that of an incandescent lamp.

This clutch may truly be said to act by causing a variation of pressure upon the carrier. It may be operated effectually by the separate action of the shunt and main magnets, or by that of both, as in most ring-clutch lamps. The application of both magnets to its action is as simple as in the coil spring itself, and is accomplished by arranging the main magnet to *bend* the coil by a lateral pull upon its lower end, and the shunt magnet to *straighten* the coil by means of a forked lever, each end of which acts upon the opposite ends of the coil spring respectively and in opposite directions. There are several modifications adapted to be applied to cause the clutch to act, and the general mechanism may be the same as, or different from that of any other lamp. Mr. Wetmore has shown as much genius and simplicity in the details of construction of the whole lamp as in that of the clutch itself.

When the main and shunt magnets are both employed to operate the clutch, the arrangement of the levers is as shown in the drawing.

F shows the carbon holder, and the helical line shows the clutch, while the main magnet operates the end of the coil, and while the other end is fixed to the support *Y*. The shunt magnet operates the lever *R*, which is forked by the branches *T* and *Z*, the two arms being adapted to straighten the spring, while the main magnet is adapted to bend the spring, and thereby retain or lift the carbon holder, according to the amount of movement upward of the lower end of the coil spring.

DISCUSSION.

Mr. **Thompson**:—Thirty years ago Lacassagne and Thiers invented the differential magnet applied to the arc lamp, and it is the preferable form to apply with any clutch. The main magnet is modeled to bend the spring laterally. The shunt magnet acts on opposite ends to straighten the spring. There is no great movement necessary; it will take place even in a smaller distance than with the ring-clutch.

The **Chairman** (Mr. **Sydney F. Shelbourne**):—It seems to your chairman, gentlemen that this matter involves a fundamental principle in the proper operation of arc lamps. I recollect three years ago being in Montreal, when the matter of arc lighting was considerably newer than it is now. They endeavored to introduce arc lamps in the dining-room of the hotel where I was stopping; but, suddenly, the lights went out, and darkness reigned, and they had to resort to gas. I also have noticed, in the past two or three years, the operation of the cluster lamps in Madison Square, and latterly it seems to me that they have operated much more perfectly than they did two years and a half ago. I think this subject is fertile of discussion and observation, and I should be very glad to hear from members present.

Mr. J. F. **Kelly**—I understood Mr. Thompson to say that what would occur in large movements would certainly occur in small movements, and I think I understood him to say, shortly before, that what would occur in large movements, with the dash-pots, would not occur in small movements. Is there not some inconsistency there?

Mr. **Thompson**:—I mentioned, and intended to keep distinct, three classes of movements. One is infinitesimal, the second are small movements, and the third are great movements. and all those take place in the action of an arc lamp. You can conceive or a solenoid and its core where variations of current will cause that core to vibrate. In the telephone, the movements can be called practically infinitesimal. Then we speak of small movements where we would vary the currents so as to produce movements, but you could not see them. The latter would be thousands of times larger than those produced by an undulatory telephonic current, and yet they would be so small that you could not see the movements. Then the other class of movements are those that are visible. All these movements occur in ordinary arc lamps. The dash-pot is not affected by the first named, while only the first two movements occur in the arc lamp under consideration.

A **Member**:—I understood Mr. Thompson to say that this motion was so uniform, that the force of gravity did not act as an acceleration. I understand that the movement is slow on account of the resistance offered by the successive rings of the solenoid. I suppose the statement was meant to be literally exact.

Mr. **Thompson**:—The principle is known, of course, that friction does not increase with the velocity, except in the case of iron against iron. It is thought that the friction varies somewhat with increase of velocity. I do not remember whether it increases or diminishes; but this, however, does not depend upon that principle. You noticed that when the holder was allowed to fall (and I was trying myself, not to perform any trick) it moved with a uniform velocity. That would not take place if I took the rod and pressed against it with some hard substance, and kept a uniform pressure on there; so the explanation must be that, just as soon as the rod begins to move, it causes the spring to spread out, and whenever a spring spreads out, it tends to spread in again, and its spreading in would prevent the carbon holder from increasing its velocity.

Mr. E. P. **Roberts**:—I understand Mr. Thompson to claim that the motion is so uniform that it does away with all necessity for a dash-pot. If that is correct, I should say that it would be most valuable in many places. I have had experience with dash-pots freezing up. One day last winter, out at Cheyenne, it took four men all day to trim 22 street lamps. In the summer you have to take them down from the poles every one to two weeks. An arc lamp has been recently patented, the coil spring in which will pull apart when it is to lift up, and when the carrier is to drop, the coils come close together and increase in diameter, and, therefore, the carbon rod drops. That motion is quite different from this.

Mr. **Thompson**:—That patent was granted to B. L. Tibbits seven months after this one was issued, and it was thought of by Mr. Wetmore and was tried, but it has the same fault about it as the ordinary ring clutch. Besides, if you try to straighten out the spring, so as to decrease the diameter of the coils—perhaps somebody, knowing more about mathematics, could tell how far that would have to be straightened in order to diminish the diameter a given quantity. I suppose that what you would have to do would be to measure the length of the spring and measure the diameter, stretch it, and then measure the length again, and form a simple proportion which would give the subsequent diameter of the coil. But it is apparent enough that, in order to increase the diameter one-tenth of an inch, you will have to pull this about one inch. I pull that about three inches now (illustrating), and yet the diameter looks just about as big. That is one fault about it. Another is that as it increases or decreases, of course all the diameters of those coils vary simultaneously at the same rate. They either hold the carbon rod or they let it fall.

Prof. W. A. Anthony:—I have been very much interested in this paper, and the device seems to me very ingenious and very useful. I rose merely to speak of what I conceived to be the theory of the action of the thing. I understand from Mr. Thompson that his idea of the action of friction is that it does not depend on the velocity except in some cases; but I have found by actual experiment that in all cases of very slow motion the friction does depend upon the velocity and that it increases with the velocity in the case of iron upon iron, and wood upon iron, and brass upon brass. After the velocity reaches a certain—not a very large—amount, a velocity of a foot a second or something like that, then the friction becomes very nearly uniform and even diminishes somewhat, but at first the friction does increase and increases considerably with the velocity. Now it seems to me that that explains very well the whole action. The pressure of the spring upon the carbon rod is a very light one, and it varies only through small amounts by a considerable motion of the magnet, as I conceive it. Now, if the pressure is diminished somewhat, the rod will go faster and so increase the friction by an increase of velocity; and if the friction is equal to the weight of the rod, then the rod will move with a uniform velocity. It is perfectly well known everywhere that when the forces acting on a moving body balance each other, the motion is uniform. Now, if an increase of velocity increases the holding force, and makes it equal to the weight of the rod, the rod will move with a uniform velocity, and that up to any velocity that would ever be allowed in the case of a moving carbon holder; so that it seems to me that that does fully explain the action.

Mr. Roberts:—On the subject of not leaving the manipulation of arc lamps to unskilled labor, I may say that, of course, there are places where the labor is almost ignorant, but the arc lights where they are in general commercial use are not in unskilled hands. I have had a good many arc lamps of different styles, and I think they all need regulating of some nature or another. Any disarrangement of parts which could not be fixed by ordinary means of course would not be desirable, but I think that most men would be able after a while to adjust a spring or anything like that about an arc lamp. I think it would only be lamps that were made for special purposes where the consideration of not having to readjust a spring or a dash-pot or something or other would have to be thought of.

The Chairman:—I understand that Mr. Wetmore, the inventor of this means of adjusting the holder of this carbon, is present, and as it does not require a formal motion, unless there is an objection on the part of the members of the society, I shall call upon Mr. Wetmore. He probably has gone through all the theories and views and studies relating to this method of adjusting the holder of carbon, and I ask him to give the society his ideas and his experience on the subject.

Mr. Wetmore:—I have had some little experience in running different forms of electric lamps, arc lamps more especially, and they are continually getting out of adjustment and giving trouble. Another thing is that they are too complicated in a certain respect. A great many of those lamps have to be put into the hands of inexperienced men, men who are not well informed as regards the principles of electric lighting, and I made up my mind that it was almost a necessity to get the lamp as simple as possible, to make the parts perform as many offices as possible, and require as little adjustment as possible. Now this method of using a spiral spring for the clutch is the one I employ. This spiral spring not only has a clutch, but I may add it forms an electric contact between the incoming wire and the carbon holder. Of course the spring is always in contact with the carbon holder and the current is not interrupted, so that I make the spiral spring perform the action of a clutch, of a dash-pot, and of an electric contact with the carbon holder. It is very easy of adjustment and requires very little attention. I do not know, gentlemen, that I have any thing further to say in regard to the matter.

Mr. Roberts:—I would like to ask Mr. Wetmore whether in running his lamps he finds any burning on his rod and whether he uses any other contact besides his spiral spring?

Mr. Wetmore:—When I first started to experiment with it I found that there was a tendency to heat, but no burning; that was when I employed a very light spring; but you will see that the spring I have here is of quite large diameter, and I found that in employing that and adding the weight of the carbon to the weight of the carbon holder, it gave me a perfect electrical contact between the spring and the carbon holder, and I found no difficulty whatever in respect to burning. There were three principal points of contact in that spring with the carbon holder, and each principal point of contact is composed of several points of contact. If you will allow me I will explain that. The spring in its normal condition is perfectly straight. I pinch it in that condition and you will see it is perfectly solid (illustrating.) Now what is the condition? There are three points of contact there. That is one principal point. Here, commencing on this side, there are several—eight or ten or fifteen. There is another principal point of contact composed of several contacts, as you see. On this side again there are one or two. Now again I employ the shunt circuit to release these coils, and in what way? The main circuit may be in operation and clutch it tightly. Now if there is more current going through the shunt circuit, I employ that shunt circuit and press it on the two sides. The result is that the spring is straightened and the carbon falls down slightly. All that is necessary is to have two forked pieces right there to press it in on that spot.

Mr. Frankland Jannus:—I would like to ask Mr. Wetmore one question: Whether there is enough difference in resistance between the clutch and the carbon rod at the period of feeding to affect the light? When it lets go, when the rod moves and of course the contact is very materially lessened, does the difference in resistance then affect the light? Is there enough difference in the resistance to affect the light?

Mr. Wetmore:—That is so far as interrupting the current?

Mr. Jannus:—Yes.

Mr. Wetmore:—No, sir; there is not. That spiral spring is always in electrical contact with the carbon holder at all times.

Mr. Jannus:—I appreciate that point; but, when it feeds, of course it is in a position of holding together. When feeding takes place, there is just as little contact as there can possibly be. Now at that time, I want to know, is there a sufficient difference in contact from what there is when the carbon holder is stationary, so as to make any difference in the light?

Mr. **Wetmore**:—There is always frictional contact with this clutch, and that differs radically from the contact of a common clutch; that lets down suddenly, allows it to drop down quickly. With this it is constant and gradual; it is an easy sliding down.

Mr. **George A. Hamilton**:—I presume the resistance is so small, compared with the resistance of the arc itself, that it makes very little difference.

Mr. **H. B. Slater**:—If I understand the question of Mr. Jannus, it presupposes the case of an irregular motion when this spring feeds, or allows the carbon to feed; hence, that there is a variation in the pressure of contact, and consequently a variation of resistance. As I understand the explanation of the inventor, there is a constant and regular motion, and therefore a constant and regular pressure there. Thus there would be no variation in the resistance.

Mr. **F. L. Pope**:—I think that the fact that there is no perceptible burning at the point of contact, shows very conclusively that there is no resistance there. The production of resistance at the point of contact of the spring with the carbon holder, if it produced heat, would be just so much heat subtracted from the heat in the arc, and would produce a variation, but we find, as a matter of fact, as the gentlemen said, that no injurious heating is shown there. It is very evident that there can be no injurious resistance there.

Mr. **Thompson**:—The weight of the carbon holder and the carbon is considerable. In order to retain that in a permanent position, requires a force equal to the weight. That force is the pressure with which the two are in contact, and of course there is no sparking or burning.

Prof. **Anthony**:—In connection with just this point, I want to say that we have a carbon holder, a carbon rod of so much weight as there is in connection with an electric lamp, which is held so that it moves steadily with a slow motion. There must be sufficient pressure on that to carry the electric circuit without any appreciable resistance. Now, if there is here a sliding, and not an actual letting go and allowing it to drop, such a slow motion necessitates a constant uniform pressure on the rod, which is sufficient to reduce the resistance to something very little—almos nothing in comparison with the arc.

The **Chairman**:—Your Chairman is not an expert in arc lighting, but a query is arising in my mind as to whether any difference is produced in the action of this spring as the carbon itself becomes consumed, and therefore makes less weight to the carbon holder.

Mr. Thompson:—All I would say would be that that amount of weight taken off would not amount to much, as 75 per cent. of the weight is due to the carbon-holding rod, which is a long tube of metal.

Read before the American Institute of Electrical Engineers, May 20, 1885.

DESCRIPTION OF A LARGE SECONDARY BATTERY PLANT FOR GENERAL COMMERCIAL DISTRIBUTION.

BY E. P. ROBERTS, M. E.
(General Manager of the Brush-Swan Electric Light Co., of Cheyenne, Wy.)

1st. Description of the storage plant.—2d. Direction for erecting and maintaining storage batteries.—3d. Remarks respecting storage batteries and their field of usefulness.

A description of our entire plant, both arc and incandescent, was published in the *Electrical World* of February 28th, 1885, and from that article will be quoted a description of our battery plant.

The Brush-Swan Electric Light Co., of Cheyenne, was formed in the fall of 1882, and was the first Brush-Swan company formed to use the Swan lamp in conjunction with the Brush storage battery and arc system. Storage batteries were put in operation early in 1883, and at the present time 99 batteries and 1,500 lamps are in operation, distributed over an area about one mile square, the charging station for the batteries being about one-quarter of a mile outside the north-west corner of the square and over 300 of the lamps being in the south-east corner.

BATTERY PLANT.

"On each block—sometimes on every two blocks—is located a small portable house, in which are placed all the batteries furnishing light for said block. A partition divides it into two parts, one for the batteries and the other for the meters and switchboard. A plug switch is used in order that any combination may be readily effected. Cable connections permit coupling batteries together as desired. An extra battery is kept in each house for use in case extra light is required.

"The batteries are placed on string pieces 2 inches by 4 inches by 10 feet; each cell rests on four porcelain insulators, and the string pieces rest on Western Union insulators, with pins set in cross-pieces. Three sizes of batteries are used, 1, 2 and 3, with capacities of 20, 40 and 80 lamp hours respectively.

"Three charging circuits are used, two to private residences, where Nos. 1 and 2 batteries are used, requiring from 7 A. M. to 1 P. M. to charge them with a 10 ampère current, and one circuit to the business part of the city, where batteries are used. As these batteries are much larger, a longer time is required to charge them, and, therefore, they are charged from 7 A. M. until 3 P. M. by a 65-light dynamo. They are then connected by switch, as desired, for the night, in some cases three batteries being connected for quantity.

"At dark the charging circuit is looped in with the all night outside arc circuit, and the charge thrown on about 20 meters, and by the connections for quantity controls about 50 batteries; thus they are left until daylight, when the arc circuit shuts down. By this means the batteries obtain considerable charge; they are then disconnected and charged separately during the day."

Directions for Erecting and Maintaining Storage Batteries.

A. CAREFUL INSULATION.

1st. Battery as a whole well insulated from the earth.

2d. Each cell insulated from all others, excepting, of course, through the proper channel for the passage of current.

3d. The positive and negative in each cell to be insulated from each other except through the liquid. No connection by moisture on the upper edge of the containing box.

B. REGULAR CHARGE AND DISCHARGE.

1st. Fill the battery every day.

2d. Discharge the battery every day.

3d. Never over-charge.

4th. Do not exhaust completely.

C. DO NOT EXPECT BATTERIES TO TAKE CARE OF THEMSELVES.

1st. Test electromotive force of each once a week with a voltmeter.

2d. Test each cell with an acidometer once a month.

3d. Each day see that each cell in each battery fills in the same time.

4th. Keep plates covered with liquid.

5th. Examine all connections frequently.

D. Keep extra cells complete and charged, with which to replace defective ones. Do not put uncharged plate or cell in battery in regular use.

E. Do not "box in" batteries. Give free circulation of air.

F. Keep all connections, switches, etc., as far as possible away from batteries.

G. Study the cause producing a new effect, and attend to details.

REMARKS.

After considerable experience with storage batteries, my conclusion is that they have been both praised and belittled too much. That the service can be good is certain; but that, for a closely settled district, they are preferable to dynamos is not, according to my experience, correct.

Experience teaches the manufacturers many points in design and formation which greatly increase the reliability of secondary batteries. Experience in handling them teaches men many little matters which greatly assist in keeping the batteries in good condition.

My plan for our new station about to be erected will show, more forcibly than a lengthy disquisition, my ideas respecting secondary batteries in connection with stations for the distribution of electrical energy.

A building is to be erected near the business portion of the city, from which our arc lights will be supplied, and in which also will be placed dynamos for running the incandescent lights in the business district. Batteries will be used in portions distant from the station. These will be charged from 3 A. M. until 7 A. M. with a 15-ampère current. At the station will be several large batteries, which will be used for day lighting or in case of a breakdown.

DISCUSSION.

The CHAIRMAN:—The subject is now before you, gentlemen. Mr. Roberts is especially prepared to answer questions in regard to the practical operation of such a plant.

Prof. W. A. ANTHONY:—I would like to ask Mr. Roberts what his experience has been in regard to the durability of the lead plates.

Mr. ROBERTS:—We have been running since the early part of 1883, so that we have had a fair experience; but what the plates will do at the present time it is hard to say, because they have improved so much. At first there were six cells in one long box, the wood of which was all continuous. The plates did not have room to expand and they were not as good, nor did we know how to attend them as well. But we have had better plates running for over a year in those batteries, which do not show any sign of disintegration. Our experience in learning what to expect, and what not to expect has been of great value, as we are enabled to attend to every little matter before it becomes too serious. It is hard to say what the most recent batteries will do. I could say as to one year well enough, but I would not like to say as to three or five.

Mr. **Hall**:—The batteries you speak of are constructed essentially upon the principle of the Planté cell, are they not?

Mr. **Roberts**:—In this Brush battery, you know, the cell—the positive—it is a gridiron in shape, corrugated ribs between two negatives, and the distance at first used to be very small; I think it was three-eighths of an inch. The idea of course at first was to get the resistance as small as possible, but I don't think that practice made much difference there. At first there was great trouble from short circuiting; a rib would sometimes at first gradually become oxidized around under the rib, and the top part would fall over and hit against the negative.

Mr. **Hall**:—That occurs especially at the bottom of the cell.

Mr. **Roberts**:—If the sediment collected; sometimes it would occur right at the top of the cell. But in the present form of battery they have room to expand.

Mr. **Hall**:—Have you ever had any opportunity to observe how the electromotive force of the cell fell off if it were not used immediately after charging.

Mr. **Roberts**:—My paper, of course, is not one of scientific figures. Nevertheless my directions for using storage batteries show that it is advisable to have them charged and discharged every day. Of course it does fall off, and for that reason I say, discharge every day. Another thing is, when they lie idle, the resistance is very much increased, and if your manipulator, as they call it in their catalogue, or if the mechanism for throwing the current on, has to overcome that immense resistance at first, you have to look out for it, because it should be made with more points of break and contact than it has.

Mr. **Hall**:—A cell of that sort deteriorates from lying idle after being charged. I wished to know what that rate of decrease was if you had observed it.

Prof. **Anthony**:—In charging are the indications of the manipulator followed or some other plan?

Mr. Roberts:—As a general thing we charge according to the manipulator which is the time of charging the battery, and which bears a very close relation to the time of discharge, when they are properly arranged. We had great trouble at first in doing that, until we introduced this storage battery-house system. Each man has his battery in that place. He is independent so far as he is concerned. The man keeps constant watch, and tells by observation, without the strain of thinking—at least he notices—if a battery takes much longer to charge than is usual. Then he tests that battery, running over each coil with a wire, and if everything seems all right, it is supposed that they use that light. If he finds anything wrong, then he makes a note of it in a paper that hangs up in the battery-house. If there is any unusual change—if a man's bill had been running six or seven dollars a month and we find it is twenty or thirty dollars—we pay attention to it; but that does not often occur. And so I think we can safely say, that the time of charging is the record by which we charge our customers, and it is satisfactory, too.

Mr. F. L. Pope:—It seems to me that we can see very plainly from Mr. Roberts's paper that a large share of his success is due to his system of placing the plant in charge of trustworthy and intelligent employees. This is a matter that is getting to be altogether too much overlooked of late years. It is coming to be quite a common practice with electrical companies to draw up a code of strict rules and regulations, mainly theoretical, and then find somebody who will work for four dollars a week to carry them out; and, in case of failure, pretty nearly everybody but themselves is blamed. And that has been quite largely the case with storage batteries, I fancy. They have been set up and placed in charge of anybody and everybody, and expected to take care of themselves; and I suppose it would be difficult to find anything that requires more intelligence and careful attention at the right time than they do. If anything goes wrong with a battery, and there is anybody who understands it to attend to it, it is rectified in a moment. If it is allowed to go on, it results in considerable damage.

Mr. Roberts:—I might say, in respect to the men, that, at first, we had hard work in getting them. It is a new country, and we have to train the men. We managed to get a few who were trained in other lines, somewhat. One of our best men had been an electro-plater and a manufacturer of electrical instruments, and our foreman of battery work has been a telegraph lineman. What we intend to do is to pay good wages, and if a man does not come to time, turn him out. We are pretty strict about that, and the consequence is we get fairly good service. But the men who attend to the batteries, who do the most work about them, are not what you would call skilled laborers. One of them had been a farmer's boy, and never had anything to do with machinery. But from constant attention to it, they get to know pretty well what to do. The foreman has been at it ever since he commenced working. He generally inspects and the others report to him. If the man who is in the battery-house, and has that circuit in charge, "blows" on the battery, to use our Western term, he gets pretty well "wound up" about it. They feel a pride in their work. I have every man, as far as possible, responsible for the work under him. Many of them take considerable pride in it, and are badly hurt if things do not go right.

Mr. R. W. POPE:—As I understand Mr. Roberts he does not pretend to compete with the commercial price of gas. It is evident that he is proceeding on a more business-like principle than a great many in the business.

Mr. ROBERTS:—The gas company started after we did. The two principal men in the electric light company and in the gas company, have been opposed in politics and stocks and everything else out there, and whenever one starts a thing, the other starts something else in the same line. Our first batteries were very defective. We did not know how to handle them. An entertainment would be given by a customer, and suddenly the lights would go out. The gas people saw their opportunity and the company was started. I favored sticking tc our price until we found how the gas company came out, because it is a good deal harder to raise your price after you have once dropped it than to stick to your price. We stuck to our price and got orders right along so we staid there. The other day a gentleman who is building a new house came to us and asked what we could furnish light for. We said $3.50. He said "I can get gas for $2.75 but I would rather have the electric light. I told what I could get gas for to see if I could induce you lower your price. But I would sooner have the electric light at $3.50." There was a very large house built the other day with handsomely frescoed ceilings. Gas was put in, and now the owner wants the electric light because the ceilings are getting darkened.

Mr. F. L. **Pope**:—I think that is a cardinal mistake that has been made from the beginning in the electric light business; to endeavor to compete with gas in the matter of price, when every well-informed electrician has been perfectly well aware from the beginning, that in the present state of knowledge, it was not possible to do it, and for that reason the attempts which have been made to furnish house-to-house lighting from central stations have not been commercially successful, as far as my knowledge extends. Now it seems Mr. Roberts has adopted a very intelligent plan in his operations. Where he can use direct lighting he is doing it. Where direct lighting cannot be commercially used he is using something else. He is adapting his methods to the place where they are to be employed, and he is endeavoring to charge a price which will give him a fair profit on what it costs him to do it, irrespective of whether the gas costs less or more. I think that any one who has had any experience in the use of the incandescent light would not have the slightest objection to paying fifty per cent more for the electric light for their house than they would for the gas light. I speak as I feel about it. I should be willing to pay fifty per cent more rather than not have it. It is in a certain sense a luxury. It is only a small part of your expenses, and you do not count them any more than you figure up your glasses of soda-water per week. Therefore I think the electric light people have proceeded very largely on a mistaken plan in that respect. Perhaps it originally came about from a feeling that people would not invest in electric light enterprises, unless they were made to believe that the light could be furnished at a greater profit than gas, at a less cost. Perhaps it was necessary to state things in that way, in order to make people put their money into it. But I think men who have done so have found out differently since that time.

Mr. **Roberts**:—I intended to mention when I was speaking before, that Mr. Potter promises to send out some glass cells. We are not using them yet, but their use will prevent the short-circuiting of cells by one touching the other, and it will largely prevent the creeping on the edge, which is also bad, and we will also be able to see down, particularly if we put an incandescent light behind the reflector, and observe the condition of the plate.

Prof. **Anthony**:—I heard something about a company that made glass cells, about a year ago, and I was anxious to know if they had been tried and what their success was.

Mr. Roberts:—I only know from hearsay, and that is what Mr. Potter told me in Cheyenne. I do not remember where he said they were used, but he said they were working well.

A Member:—We use glass cells for secondary batteries. We used wooden boxes, but we found that, after a month or so, they began to leak and then made some stronger boxes. The last two were made of glass, and now all the cells are made of glass. They put india-rubber between the plate and the glass; that is as we use it in Europe.

Mr. Roberts:—Those strips must be in the liquid. The liquid must go to the glass. Therefore those strips could hardly be insulators. They could only be used to keep the cells in position.

The Member:—The strips are on the outside, and inside there are only pieces.

Mr. Thompson:—How are those joints made in the cells? You say they leaked a little at first, and then they did not leak. I made a lot of cells by flattening the lead, cutting in certain directions so that, when folded up, it makes a complete box, and then taking a Bunsen burner, and getting a little sharp flame; and by teaching the mechanic a little, and by his practising, he could run that along slowly, and could make lead pots. About two years ago I saw some of the Brush cells. They were simply soldered. I tested one and it was leaking. They would last for a long time, because the acid attacking the solder would take a long time to eat through the solder, the solder being placed on the outside, and the acid attacking only a very small area of the solder at once. I was wondering how they were made at present.

Mr. Roberts:—The way they are made of course I do not know, because we get them from the Brush Company. The first did leak, but they did not leak so much on the solder joint as they pitted through. They claimed that the lead was not pure and it was not heavy; a little indentation would almost go through. I presume they make a burnt connection. There is no solder used. It is all lead and fused together. I do not know their exact method of manufacture.

Mr. Shelbourne:—This whole question of the cost of electric lighting, compared with gas, depends upon so many conditions and considerations, that it would be hardly fair to make an estimate off-hand on the cost of one or the other. It has been stated generally in the newspapers that the Edison Company claim, in regard to incandescent lighting, that they can furnish light cheaper than gas. I do not know whether that is directly claimed by the most responsible persons in the Edison Company or not. My friend here, Mr. Pope, seems to take it for granted that it ought not to be considered that lighting by electricity is as cheap as gas. Now this whole question depends upon just the relative conditions of giving an equivalent for the money. It is a *quid pro quo.* Do you get your money's worth? What are the conditions that enter into the question of the value of the electric light? Well, it has been stated and considered that one of those conditions is the comfort that you derive from the electric light, the mellowness and steadiness of the light, the freedom from carbonic-acid gas, and those other considerations. Another very important thing depends upon the photometric quality of the light—the amount of light that is given. Take the arc light in this city. The Common Council have requested the board that has charge of the lighting of the city to put the electric light in certain streets. Recently the city official having charge of the gas and the lamps reported that, taking the streets where the electric arc light was used for lighting, they cost so much. The gas lamps that were replaced by those arcs cost so much. The result was that the cost of the electric arc lamps was about three times as much as the cost of the gas lamps displaced. It was stated, however, in the report that no question was made as to the amount of the light. Now that is very important. The question is as to the amount of light, and as to the comfort that you derive from the light. That furnishes the *quid pro quo*—getting your money's worth. Of course, when you come to incandescent lighting, people who have had gas in their rooms, when they supplant that system with the system of incandescent lights, they would not be satisfied with the same amount of light that they had been deriving from gas. They want something that is better; they want something that is new, and that furnishes them with something different from what they had before. They get at least fifty per cent more of light with the incandescent light, and then they go to work to compare the cost of their previous gas bills, and they consider—well, really this light cost fifty per cent more than our gas. They have not measured the light. There are so many different ways of measuring the quantity of light and such variations in regard to the accuracy of instruments in measuring lights, and so many considerations in regard to measurement that they never put the question to the practical test—that is, how much light do we get for so much money? Until these matters are reduced to careful calculations and measurements based on experiments, it will be impossible to say what the value of the light is or how much money it costs.

Mr. Roberts:—Our electric light company is a small corporation, I mean the number of men in it; there are only four. Two are residents of Cheyenne and the other two are there only during the cattle season. They distributed the stock very largely, and they have got a number of men interested more or less, in one way or another. The question came up before the Common Council last Fall, as to whether we should have the electric light or gas for the streets. The gas people fought pretty hard and we did our best, but were only two against a large number. But when it came to a general discussion on the street and the members of the Common Council found what their constituents were going to say, we had a majority in the board and they voted unanimously for the electric light. The gas company bid a hundred and thirty-five lights of customary candle power, as they called it, which gave rise to a few remarks on my part, because customary is rather an odd term to bid, and we bid 22 lights and secured the contract for three years.

Mr. Hamilton:—In this particular plant about what percentage of the charge is returned. I should be very glad if Mr. Roberts could give us any information in regard to this.

Mr. Roberts:—I have said that my paper is not one of figures and therefore I do not feel quite ready to answer questions respecting matters of that kind. The Brush Company reported seventy-five per cent as the efficiency, and I do not see any reason to doubt it. It depends very largely upon the conditions.

The Chairman:—There has been a good deal said about the comparative cost of incandescent lighting with that of gas. Now it has not been stated, but I do not think there is any question about it, that gas at the present time is far more costly than kerosene, and yet it displaced it. Now it seems to be thought by some, that electric lighting ought to cost more than gas, and it is stated by some that even on those terms it ought to hold its own. I think Prof. Card can give us some information on that. The point is this, that up to the present time, the discussion has elicited the fact, that in the plant operated by Mr. Roberts, they obtained higher prices for incandescent electric lights, than are charged for the same amount of illumination by the gas company in his town based upon the question of quality. The chair merely suggests that we would like to hear from Prof. Card, what his ideas are of what the relative prices should be between electricity and gas, in this part of the country.

Prof. Card:—I did not expect to say anything when I came in here, but this question of electric lighting, or as I call it thunder and lightning business, selling the lightning and throwing in the thunder for nothing, is a good deal a question of education. You take kerosene. It doesn't cost a great deal—fifteen cents a gallon. You take your gas at $1.50—it doesn't cost a great deal. But if you can get a better light from the gas, you don't count so much the difference in cost. As this gentleman says, if you can get a better light from the electric light, you do not consider the cost of the thing. As to the relative cost of running a plant, why it depends largely as this gentleman said on the conditions—what the size of the plant is, how many hours you run it; because for a fifty light plant, it will take about the same organization as for one of five hundred. If you run it but an hour, you have to have your men look after it as though you ran it ten hours a day. The longer you run an incandescent lamp, the cheaper it is relatively. It seems to me the reason of that is apparent. To go back to the start, it is a matter of education. When you bring out a new art, people don't know much about it. They learn by observation. They study the thing up and figure it up. You show it to them and show them it is a good thing and just what they want. They don't look at the element of cost at first or at any time. If it is an improvement, if there is more comfort to it, if it is healthier, if a man wants to fix up his house nicely, and to decorate it with fine tints and colors, that the sulphur from the gas would tarnish, while he could put in the incandescent light and save those tints and colors, that is an argument in favor of it. From my observations here in town, since this incandescent lighting business has been running, there is nothing like the opposition to it, on account of the cost that there was, because it can be made to come pretty close to any decent sort of gas. The incandescent light can come very closely to it, so near that there is nothing like the talk as to matter of cost that there was, because it is so much better than the other.

Mr. Slater:—There is one point that I think has not been touched upon; that is the matter of health. I think in that respect especially the incandescent light far surpasses the gas light or the light of the kerosene lamp. When a gas light or a kerosene lamp has been burning in a room and one comes in from the open air he can detect its presence at once. I cannot remain in a room where a gas light is burning without inconvenience. There are a great many who are the same, and who suffer from that cause in various ways. With the use of the incandescent lamp we have nothing of the kind. The air is not vitiated at all. The light is steady as compared with the gas light. In fact it is perfectly steady you might say. A great many, like myself, cannot read by the gas light. I cannot use the gas light at all. I have to use a kerosene light for the purpose of reading, and the incandescent light surpasses the kerosene light in that respect. The health is affected by the effect on the eyes. The health is affected by the vitiation of the atmosphere of the room; and taking all together, the comforts derived from the use of the incandescent light, as compared with the gas light, are considerable, and we should not, I think, consider the difference in price. Of course it is a matter of education. You and I can buy butter for forty cents a pound. Our neighbor can buy butter for twenty-five cents a pound. It is all butter; but I could not eat the twenty-five cent butter. I should suffer very much in my digestive apparatus, if not otherwise. Fuel, which we generally call coal, is all coal; but one kind of coal perhaps cannot be used in the house, which we purchase for, say four dollars a ton. We pay five dollars. It is only coal; it is all coal, and to the ordinary mind it is one and the same thing; but we get a better result and a more economical result from the higher priced coal. We certainly get a better result and a more economical result from the use of the incandescent light as compared with gas, although we pay a high price for it. The doctor's bills will certainly be less than with the gas light, and there will be a higher degree of comfort. As has been well said, it is all a matter of education; people should be brought to see the difference in the effect upon the health, and the difference in the volume of light. It has seemed to me that if some instrument could be invented which could be supplied to the people cheaply, to measure the volume of their light, or be placed in the hands of such parties as are selling light, to be used when advocating the sale of their light, whether by gas or electricity, then the people could see the difference. As it is now, it is hard to get some people to detect the difference even between a gas light and a kerosene light; I mean the ordinary kerosene burner. It is very difficult also for them to see the difference between the incandescent light and the gas light. I have met people who could not see the flickering of the gas light when I could not see to read for that reason. But such people cannot be convinced unless some instrument can be produced by which the volume of light can be measured and it can be shown there is a difference between the two lights, just as there is a difference between a pint and a quart measure.

Mr. Roberts:—Taking up the gentleman's last remark, first, I would say that I made an exhibition in the Windsor House at Denver, some years ago, some gentlemen having requested me to show if there was any difference between the lights. They turned off the electric light first and tried to read by the gas light, moving away from it gradually, and then they tried the same thing with the electric light and they found they could move much farther from the electric light than from the gas light and read. In a printing office I know of a case where the proprietor wanted to dispense with the electric light, and the men said, "If you are not willing to pay for it, we will pay for it; we do not wish to do without it." In the jewelry store at our place the man who repairs watches has to have a light close to his eyes and he always used a student's lamp before—well, a student lamp is as good as a gas light, I think—and he could not work late at night on account of the trouble from heat, etc., and he prefers the electric light. If a man is a small consumer of light and he uses kerosene, and his bill for kerosene comes in with his groceries and the servant girl cleans his lamps, it does not amount to anything; but I have put an electric light in a hotel for what they paid a man to attend to the lamps. They paid a man two dollars a day to attend to the lamps. We have lighted two hotels there and I certainly think in one of them it cannot cost much more, if any, than they used to pay for attendance. In one of them they were refitting, putting in new carpets, and we kept them waiting four or five days to open that part of the hotel. They would not start that part of the hotel with kerosene oil, because, they said, the men might spoil enough carpet with the oil to pay for the difference. The advantages of an incandescent light are too well known to go over; but the advantages are recognized very largely by people who use it right along, and with it they can economise in so many ways that they cannot economise with gas. Two nights ago I arrived at my old home near here. I wanted to light the gas in my room during the night, and in trying to find a match I tumbled over chairs and other things. Now, at home I have no trouble of that kind.

Prof. CARD:—I have here a clipping that I took from a newspaper. I do not vouch for the truth of it; but if there is any truth in it, it emphasizes the remarks made by a gentleman a moment ago as to the hygienic effects of artificial light. It is an extract from a lecture by Mr. R. E. V. Crompton, at the Health Exhibition in London. "Turning now to the comparative heating and air vitiating properties of artificial lights which we shall find it convenient to take together, I have here a table prepared showing the oxygen consumed, the carbonic acid produced, and the air vitiated by the combustion of certain bodies burning so as to give the light of twelve standard sperm candles, each candle burning at the rate of one hundred and twenty degrees per hour:

	Cubic feet of Oxygen Consumed.	Cubic feet of Air Consumed.	Cubic feet of Carbonic Acid Produced.	Cubic feet of Air Vitiated.	Heat Produced in lbs. Water. Raised 10° F
Gas.......	5.45	17.25	3.21	348.25	278.6
Elec. Light	None.	None.	None.	None.	13.8

Mr. ROBERTS:—There was one remark made a little while ago, to the effect that the expense of running depended somewhat upon the labor and the number of lights. We have to furnish lights during the daytime to cellars, dark offices, etc. Now we are going to have large batteries, as I mentioned in the paper. We have large batteries there in our stations. Those will be charged during the night time and they will be switched on to the main line during the daytime. Therefore we will not have an extra relay of engineers and firemen, and in case of a breakdown we will switch those on at once. It is done by the movement of a handle, of course. If the breakdown is in the power, we order an extra engine, and before the engine reaches us we have its capacity nearly filled up, and are obliged to get another one. We supposed we had a hundred per cent. more power than we needed a year ago and now we haven't enough.

Mr. F. L. POPE:—I would like to ask Mr. Roberts if he knows of any other similar storage plant and incandescent outfit running anywhere in the country.

Mr. ROBERTS:—No, sir; we have the only one, so far as I know. We started first and have been pretty much alone. We have had a good many letters of inquiry to know how we were getting along, etc. We had some pretty hard times, but we had enough pluck to stick to it. I have heard from Mr. Martin that there were some gentlemen in town who said it was very pretty out at Cheyenne, but that is out of the world. But, for all that, it is connected pretty closely with the rest of the world and a great many men know pretty well what is going on out of Cheyenne. I went to quite a stylish store in New York recently and they had an old-fashioned Brush lamp burning. They would not have such a thing as that out at Cheyenne. They insist on having nice brass lamps.

Mr. F. L. **Pope**:—The impression had prevailed that the system had been an entire failure, and it certainly was quite a surprise to me and to a great many others, I have no doubt, to hear of what Mr. Roberts had been doing and of the great measure of success that attended him. It is evident that he has got through the worst part of it and will have plainer sailing from this on.

The **Chairman**:—About a year and a half ago an incandescent plant was put into the Smithsonian Institution at Washington, by Mr. Shea, and so long as it was operated at all it was quite successful, although it was not operated long enough to furnish any comparative data. Then there is another incandescent plant in Washington at the printing office of the *Republican* and *Post* newspapers. That has been in operation for more than a year and a half. In fact I think it is more than two years now. That is operated direct from the dynamo. I have never, however, had any of their figures and cannot give the expense.

Mr. **Roberts**:—The plan of using in the station, is what I believe to be the best use of the storage battery. I believe we will make a good thing out of it. We don't look upon the storage battery as a failure; but we do not believe in it where we can get a number of customers close together and where we can get a station near it.

Mr. **Martin**:—I am responsible, according to Mr. Roberts, for putting up a job on him apparently. But I was so much interested in the statement he made to me that I suggested he could not bring a more timely subject before the Institute than the subject of storage batteries. There is one point I want to inquire about, "Batteries will be used in places distant from the station." From that I gather that the lights are used in private houses.

Mr. **Roberts**:—Yes; very largely. We have two private residence circuits. We have lights in every conceivable place there almost. We have them in houses of all kinds of repute. We have them in gambling houses, churches, private residences, business places and every possible place you can imagine. We have them in the telegraph office and in the despatcher's office of the Union Pacific Railroad, and for all those places we are obliged to have special arrangements.

Mr. **Martin**:—In that case are you prepared to give your support to this statement which I find in the *London Electrical Review* of May 9th, which I received yesterday:

"Two years ago, or even less, we should have been very guarded in anything we had to say in eulogism of secondary batteries, but such very decided improvements have been made in these apparatus that for such purposes as that to which we have referred before they may, under periodical and intelligent inspection, even now be safely recommended, and it is not too much to assume that as they are better understood so will further improvements follow."

If you after your experience can endorse that I think it would be saying a good deal for the secondary battery. I should also like to know if you can say anything regarding the use of secondary batteries on the railroads of the country.

Mr. **Roberts**:—As to railroads I can say nothing more than what Mr. Potter told me the other day. I think he referred to the Pennsylvania Railroad. The results thus far obtained were very promising. With respect to the extract from the paper which Mr. Martin has read, I do not see any exception to be taken to it, provided consumers are willing to pay for what they get.

In such cases where they have water-power it would probably be cheaper to have a dynamo and a storage battery than gas. In other places it might be cheaper for them to put in gas. The main fact that they would under periodical inspection give a good light and be fairly economical I think would be correct.

Prof. **Anthony**:—I have never been able to find out yet what a storage battery costs—the first cost of one—and if that can be told, I should like very much to know. Of course, if it is a secret, I do not want to press the question.

Mr. **Roberts**:—All the information I have on that point is from the private circular of the Brush Company. It is a private circular, and I am compelled to refer you to the Brush Company.

Mr. F. L. Pope:—From all that has been said it seems quite clear that the field that has been occupied by the storage battery is in the way of supplanting the direct system of incandescent lighting. This direct system is only practicable now for very short distances from the central station. When you go very far away, the interest on the cost and maintenance of your conductors mounts up so rapidly, that the cost becomes prohibitory. Now the storage system is evidently going to permit the economical extension of incandescent lighting systems to a much greater distance from the central station.

Mr. Roberts:—I think by next fall we will be lighting a group of residences—new residences about two miles from our station; but it will depend somewhat on how we come out with another group in the same direction. If the Government takes hold, the officers will probably light their residences also. Mr. Martin hands me a paper here saying that the Boston *Herald* has an isolated plant of about three hundred lights and it costs less than gas.

Mr. Martin:—In their case would it be to their advantage to light from a central station or storage?

Mr. Roberts:—It would be advisable for them to stick to what they have most decidedly.

Col. Hazard:—I should like to ask, sir, whether the question of generating by wind power only, has been the subject of any experiments—that is charging the dynamos by the wind only.

Mr. Roberts:—Respecting wind only, one or two gentlemen in Cheyenne who have ranches far from town have spoken to me about it, and I have been too busy to go out and give them any figures But when you have your machinery and engines, and are obliged to have skilled labor, I think that the steam engine is the best. Very large windmills would be necessary. Say you put in fifty horse power. I believe that a twenty foot mill doesn't give more than one and a half horse power, and you would require a good many to give fifty horse power. Then our air is rare, though we have a high velocity at some seasons of the year. If you had windmills alone, you would have to have an extra storage plant to last you at least two days.

Prof. Anthony:—There may be cases where wind power would be valuable for such purposes for an isolated plant, but it seems to me that in most places there would be days or even a week together, where the mill would not run with sufficient velocity to generate current enough to charge the battery. Unless you had the wind to do that, you would be without a charge for days together. It seems to me it would be an exceedingly unreliable power. My own feeling in regard to it is, that steam power is the power for electric lighting; that even water power is not a power that is to be considered in comparison with steam; except under very favorable conditions. There are of course cases where the conditions are so favorable, where you can use it and rely upon it continuously from one year's end to another; but in a great many cases the water power fails at just the time you want the light. At Ithaca, where we are doing something in the way of electric lighting, and have water falls enough—if the fall were all that was necessary—to generate any amount of power. We have between our University and the lake about four hundred feet of waterfall; but the trouble is that in some seasons of the year there is not much water. If we could be sure of water, I think we might use water power with perfect success; but occasionally the water fails and then again there is more or less trouble from the running of debris in the stream that clogs up the wheels, and my feeling has been that if we want a continuous and reliable electric light, something that will not fail us on occasions; if we want a light that people can always have at command when they want it, like gas light, there is nothing like the steam engine.

Mr. Thompson:—We had a windmill which we connected up over night with a steam engine accidentally. In the morning we found the steam engine running without any steam.

Mr. R. W. Pope:—In regard to water power, I was at one time with an establishment where we needed a continual supply of paper for ticker instruments. Our paper came from a Holyoke mill. At one time they didn't have water enough and again there was a freshet, which interfered with the manufacture. So I got discouraged and hunted up a paper mill in New Jersey that ran by steam and we had no further trouble in that respect.

Prof. Anthony:—I have been very much interested in this discussion and in the original paper, and I have been watching this storage battery question ever since the storage battery was introduced. It seems to me that the storage battery is as necessary for the solution of the problem of electric lighting as the gas holder is for gas lighting. I think that the thing we want is coming sometime. But there are a great many questions involved and one of these is the original cost of the battery; that is what prompted the question I asked. I have heard the statement made that a storage battery that will do the same work costs three or four times as much as a dynamo, and a great many people have said who profess to know something about it, that the first cost of the battery, the interest on the cost and the depreciation were so great as to almost prohibit the use of it; and I am very glad to know that Mr. Roberts has found the thing such a success that the plant is being increased. That is evidence to me that they have found it valuable at any rate, and I do not see how it is possible for us to extend over any large area this system of electric lighting except by some such means. Certainly we can light small areas directly from the machines, but when you come to go any distance you must have the storage capacity, and until you have a battery you can use, you have not reached the solution of the problem of electric lighting.

Mr. Carey:—Mr. Roberts has kindly given us a great deal of information upon the importance of charging and discharging the batteries. I would like to ask him to give us a few words explanatory of the disadvantage of failing to do that, and whether or not it would be at all practicable to carry this charge in the battery for a length of time; provided our power was furnished for nothing as by the windmill.

Mr. Roberts:—Of course if you overcharge you must disintegrate, and you also oxidize your plate. Respecting leaving it uncharged, it does not deteriorate rapidly to leave it uncharged. It is a great deal better to take the plates out and pile them up. If they stay in the liquid and are neither charged nor discharged; there is an action going on continually which gradually disintegrates them. To do it every day is the point we aim at and which we succeed pretty well in following.

Mr. Carey:—What age have you given to any of these batteries without using them?

Mr. Roberts:—Well, I do not know. We have not had any time, or an experimental laboratory to do anything, to see how bad it was.

Mr. Slater:—With regard to leaving the storage battery uncharged I have had a little experience. I have a series of six at Elizabeth. They are made of lead, two pounds per square foot. They have been left uncharged since the first of January, and within the last ten days I have had to pick the rims of the plates out of the bottom of the cells, all disintegrated and destroyed.

Mr. Roberts:—The first exhibition we made we ran for over two hours with four lights, with two No. 2 batteries, using the charge that had been in them before they were shipped to us. If they are shipped dry and kept dry it is all right; but if you put them in the liquid and let them discharge, the resistance is very high.

The Chairman:—I think we owe a great deal to Mr. Roberts. He has come a long way to read his paper to us. I do not think there is a member present who has not been intensely interested in what has been said; and I think that the information Mr. Roberts has been able to afford us is really exceedingly valuable, because of the very small amount of attention that this subject has received, and I think that we ought to express our thanks to him at least, verbally.

Mr. Roberts:—After the Chairman's very kind remark, I would say that I was only sorry that I could not elaborate the subject a little more. When Mr. Martin first asked me to write a paper I did not expect to come East and read it. I was rather afraid that when I gave this short paper, it might be considered that I did not feel the honor that I ought to feel in reading a paper before the Society. Instead of that I am very highly gratified by the reception it has received.

Mr. Martin:—I move that Mr. Roberts be asked to present at our next meeting, a paper stating the progress he has made with his secondary battery plant in the interval.

The motion was carried.

Mr. F. L. Pope:—I suggest, Mr. Chairman, in connection with the paper we have assigned to Mr. Roberts, that I am sure all the members would be very glad to have any information which he may find convenient or possible or proper to give us, in relation to the actual cost of working the plant. That is a matter of a good deal of importance, and with the experience he has had, he may possibly throw more light upon it than we could get from any other source.

A paper read before the American Institute
of Electrical Engineers, May 20, 1885.

DELANY'S SYSTEM OF FAC-SIMILE TELEGRAPHY.

BY PROF. EDWIN J. HOUSTON.

Fac-simile telegraphy embraces the methods by which chirography, outline sketches, maps, hieroglyphics, etc., produced at one end of a telegraphic line, are automatically reproduced at the other end. Such a system embraces a transmitting instrument at one end of a line and a receiving instrument at the other end. These instruments, though varied in form, consist for the greater part of similar surfaces maintained in approximately synchronous motion. The message is written or drawn on one of these surfaces, and is automatically reproduced on the surface at the other end of the line.

Numerous and various devices have been invented for the transmission and reproduction of fac-simile despatches. The principal of these may, however, be arranged under two heads. In one of these classes a pen or stylus, moved by the hand through a magnetic field, sends thereby a series of electrical impulses over the line that produces corresponding movements in a similar pen at the other end of the line. In such apparatus the handwriting or outlines are reproduced directly on the paper or other material that is placed on the surface of the receiving instrument.

In the other class, which embraces the greatest number of apparatus, the transmitting and receiving devices are of the same construction and consist of similar metallic surfaces, such for example as that of two cylinders maintained in approximately synchronous motion, and each provided with a pen or stylus that is caused to move over the surface. The pen or stylus is connected to the line so that the current passes from the transmitting instrument over the line and into the receiving instrument. The message to be sent is written on the surface of the transmitting cylinder in any non-electrical conducting ink, and the surface of the receiving instrument is covered with ordinary Bain paper. When now the instruments are simultaneously set into motion, as long as the stylus or pen is in contact with the metallic surface of the transmitting instrument, it causes a continuous blue line to be traced on the Bain paper at the receiving end. When, however, the stylus or pen is moved over the surface of the non-conducting ink, the circuit is interrupted and the corresponding points on the surface of the receiving cylinder are left unchanged. The design traced on the transmitting instrument is thus reproduced on the receiving instrument in white on a blue ground.

Bain was the pioneer in fac-simile transmission. His devices, which were produced as early as 1843, belong to the second class of apparatus. To the same class belong the inventions of Bakewell in 1850, of Hunter in 1852, of Caselli in 1858, and of Bonelli. The devices of Lenoirs, of Sawyer, of Edison, of others may also be included in the same class.

The apparatus of Jones, produced 1855, and of Myers, belonged to the first class.

Thurrell, Müller and Chidly, in 1856, produced, jointly, an apparatus for fac-simile transmission, in which a magnetized point or roller was moved to-and-fro over the surface of the transmitting apparatus. While the magnetizing current continued to flow, a similar point traced a continuous line on the receiving surface, but whenever a break occurred, as, for example, by the non-conducting ink, the point was drawn away by a spring. The successive makes and brakes so obtained produced on the receiving cylinder the design traced on the transmitter.

Hitherto, the various systems of fac-simile transmission have failed in their successful commercial applications, either because of their unreliability or from their great expense. When a single stylus or pencil was employed, as in the system of Bakewell Caselli and others, the method was slow in operation and unreliable in its results. Bonelli's introduction of a multiple comb or stylus, in which a series of styluses or fingers at each station were employed, connected between the two stations by a cable containing as many single conducting wires as there were fingers in the compound stylus at each station, increased the speed of transmission.

Bonelli's system, as will be readily understood, was a great improvement on the systems known at the time of its invention. Two difficulties, however, existed which have prevented its extensive use. These were, 1st, the great expense of construction when the cable connected two distant stations, and 2d, the unreliability in the results attained, owing to interferences in the strength of the momentary impulses sent through the separate wires of the cable, by induction in or by neighboring wires.

Mr. Delany has happily applied his system of synchronous-multiplex telegraphy to fac-simile transmission and has attained results that appear to render the actual commercial application of fac-simile telegraphy practicable. His system briefly consists in dividing a single telegraph wire, connected at each of its ends to a multiple comb, or series of styluses, into as many separate and practically distinct lines as the separate and distinct styluses at either end. The division of the single connecting wire into a number of separate lines is effected by his system of synchronous multiplex telegraphy, now so generally understood.

The means, whereby this application is made, will be better understood by an examination of figure 1, for which, in common with all the figures used in this paper, the author is indebted to the United States Letters Patent, granted to Mr. Delany for fac-simile transmission. In Fig. 1, is shown the transmitting and receiving apparatus connected with the synchronous distributer. In this figure *X*, and *Y*, are the two stations. *A*, is the rotating disc, and *a*, its trailing finger or circuit completer, mounted on the axis of the disc *A*. *B*, is the circular table of insulated contacts. Eighty-four of these contacts are provided in this case, divided into six series of fourteen each.

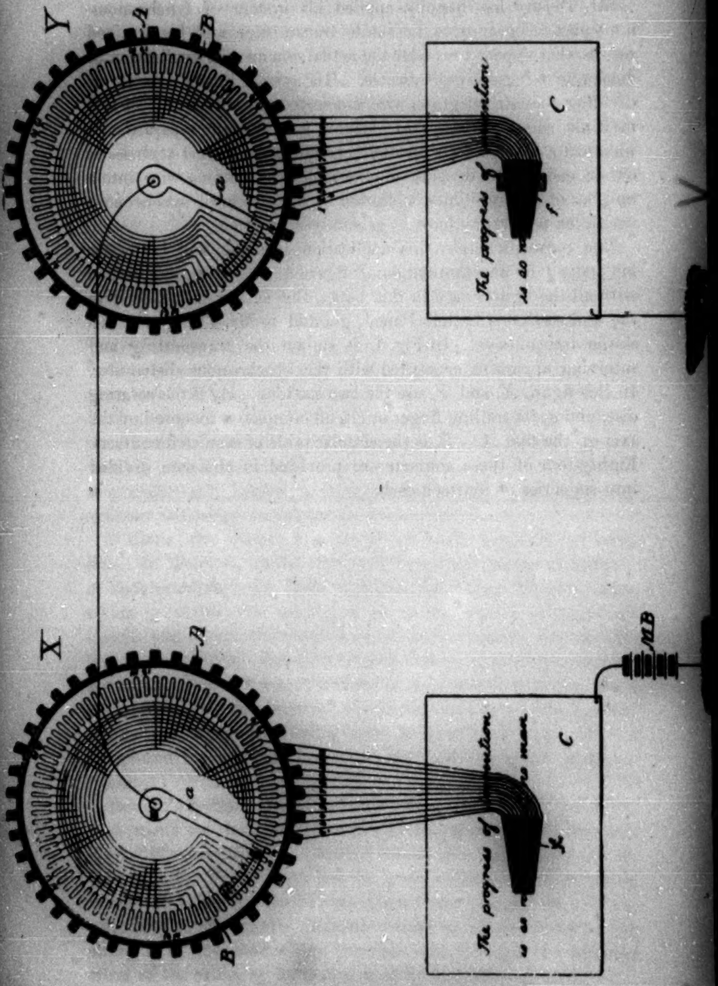

Y
A
B
a
C
f
The progress of invention
X
A
B
a
C
k
MB

FIGURE 1, DELANY'S FAC-SIMILE APPARATUS.

The 13th and 14th contacts in each of these series is not shown as connected in the figure, these contacts being reserved for the synchronous correction of the apparatus, in accordance with the Delany synchronous multiplex system.

Supposing the contacts in each of the six groups to be numbered from 1 to 14 consecutively, the number-one contacts in each of the six groups are connected together and to a line marked 1, at station *Y*, and the corresponding contacts similarly connected at station *X*, to a line marked *X*. The number-two contacts at each station are similarly connected to one another and to a line marked 2, and so with the other contacts, the 13th and 14th in each of the groups being reserved for the sychronizing of the line as already explained.

Each of the lines 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, so provided, is connected to an insulated finger or stylus *f*, that forms part of a comb that moves over the surface of the transmitting and receiving instruments *C*, *C*.

When now the synchronously moving fingers *a*, *a*, move over the contacts, they simultaneously rest on similar or corresponding contacts at each end of the line, thus completing the circuit from the insulated finger *f*, in said circuit 3, at station *X*, with the insulated finger *f*, in circuit 3, at station *Y*.

If the trailing fingers are rotated at a speed of say three times per second, the circuit will be completed over each of the twelve lines so provided between the two stations, eighteen times a second. At this rate a high speed of transmission is attainable. The insulated fingers are arranged, as shown in the figure, on a comb in close proximity to one another, but separated by some good insulating material. The plates *c*, *c*, on which these fingers rest, are maintained in approximately synchronous motion by clock-work or other suitable mechanism.

The battery *M B*, at one of the stations as *X*, has one of its poles connected to ground and the other to the metallic plate *C*. Let us suppose now that *X*, is the transmitting station and *Y*, the receiving station, and that the message to be transmitted is written on the surface of *C*, at *X*, in some electrical non-conducting ink, while the surface of the receiving apparatus at *C*, is covered with a sheet of Bain or chemically prepared paper.

When now the ends of the fingers *f*, at *X*, are in direct contact with the metallic plate, the circuit of the battery *M B*, will be independently completed through each of the twelve lines, eighteen times per second through the fingers at *Y*, to the ground, and will thus produce the well-known blue marks or lines on the paper at that station. When, however, the circuit is broken by the trailing finger at *X*, coming in contact with the insulating ink, the otherwise continuous line marked on the paper at *Y*, will appear broken, no discoloration appearing at such point. Whatever therefore is traced on the transmitting surface is automatically reproduced on the receiving surface in white lines on a nearly continuous blue ground.

Although any series of points in a straight line in the design traced on the transmitting surface, that were simultaneously touched by all the twelve separate and independent fingers, would not be actually reproduced on the surface of the receiving apparatus as a rigorously straight line, since the electrical impulses would not be simultaneously sent over all the lines but over each in succession, yet in actual practice the completion of the circuits in each of the separate lines occurs at such frequent intervals, that the deviation from the straight line in the case supposed is not discernible, and the effect is the same, as if the corresponding fingers at the two stylusses were actually connected by separate and independent main lines.

In figure 2, are shown some of the details of the multiplex stylus or comb with its trailing fingers.

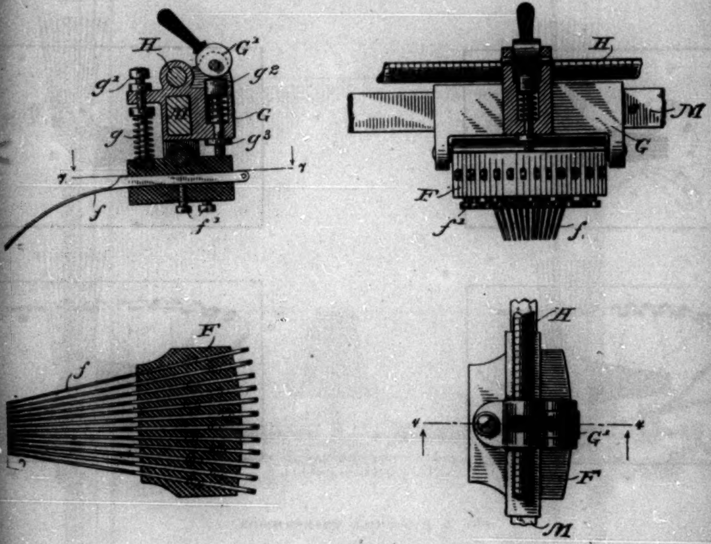


FIG. 2. DETAILS OF MULTIPLEX STYLUS OR COMB.

The separate fingers *f*, are mounted in the insulating block *F*, by being pressed through slots or apertures in said block. Set screws f^1, are provided for holding the fingers in position and for permitting their adjustment. The block *F*, pivoted at *G*, moves over the screw threaded shaft *H*. A spring *g*, adjustable by g^1, keeps the stylusses pressed against the surface of the metallic plate *C*. The depression of the trailing finger is limited by the bolt g^2, and its collar g^3, in the manner shown.

The cam G^1, is provided for pressing down the bolt g^2, so that when *C*, has reached the end of its motion, the fingers may be held away from the plate *C*, while it is being drawn back again into position.

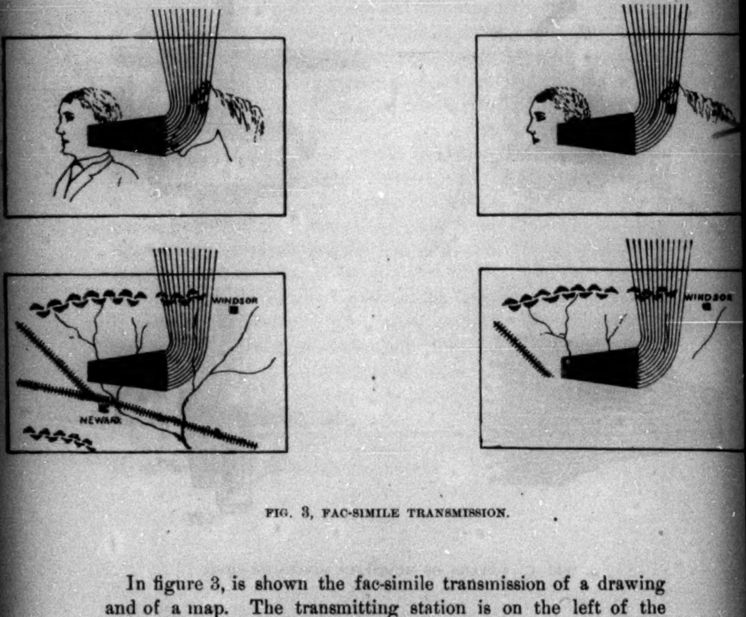


FIG. 3, FAC-SIMILE TRANSMISSION.

In figure 3, is shown the fac-simile transmission of a drawing and of a map. The transmitting station is on the left of the drawing, the receiving station on the right.

Any method may be adopted for the motion of the movements of the transmitting and receiving surfaces *C*, *C*. Mr. Delany has shown a number of such devices in his United States Letters Patent. In figs. 4, 5, and 6, are shown the details of a device suitable for obtaining a reciprocating motion of the plates *C*, *C*. The frame of the instrument is shown at *I*. The plate *C*, is driven by a rock C^4, actuated by any ordinary clock-work *K*. A screw shaft *H*, has its bearings on the lugs or vertical standards *I*, situated as shown. The comb is carried by the frame *G*, which moves laterally on the string-bar *M*, connecting the standards *L*, *L*, as the shaft *H*, is rotated.

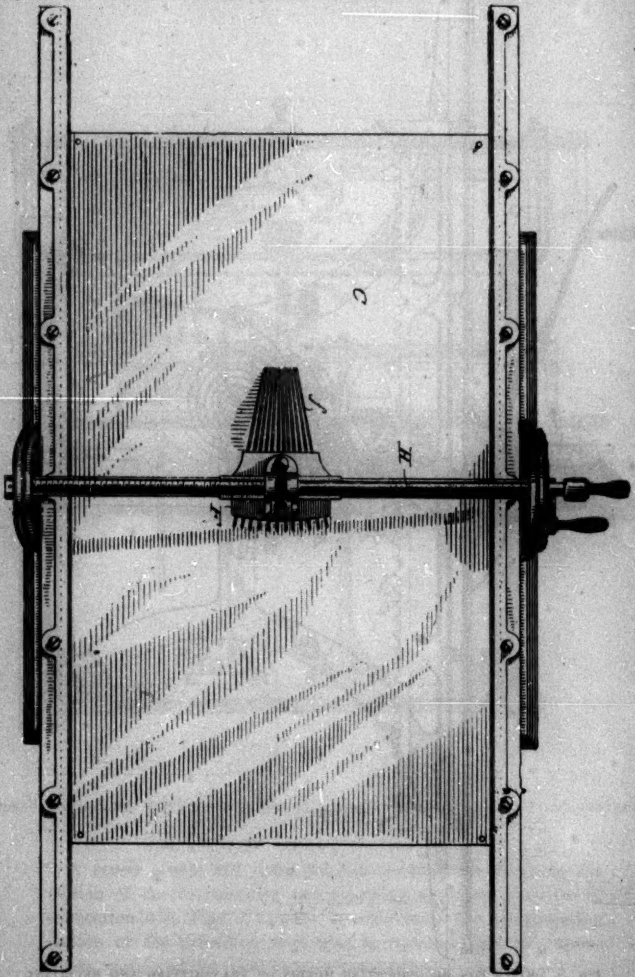


FIG. 4, FOR RECIPROCATING MOTION OF TRANSMITTING AND RECEIVING APPARATUS.

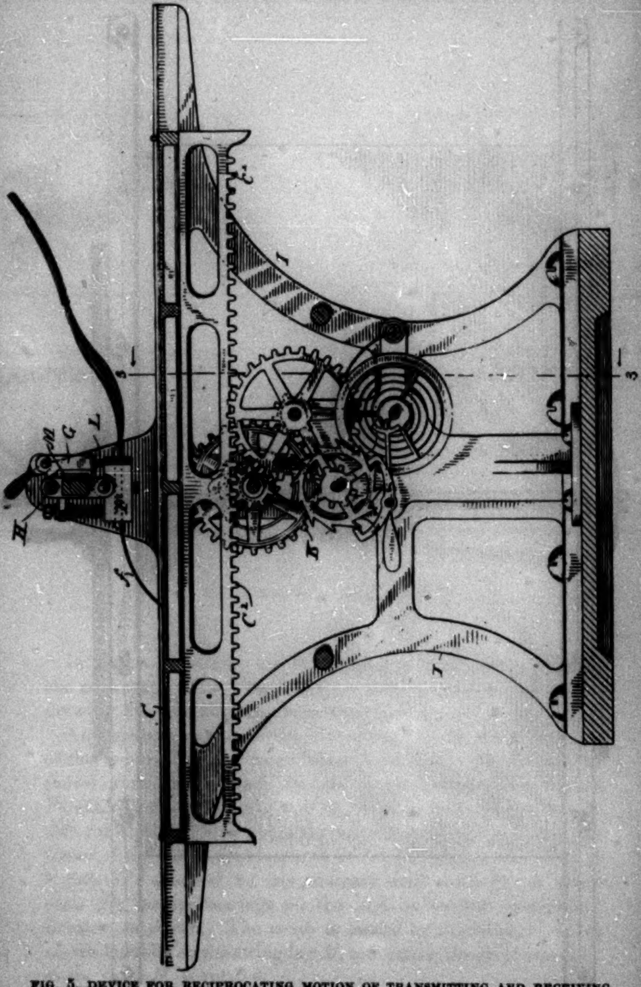

C²
I
f
3
3
M
G
L
H
f
E
C¹
I
C

FIG. 5, DEVICE FOR RECIPROCATING MOTION OF TRANSMITTING AND RECEIVING APPARATUS.

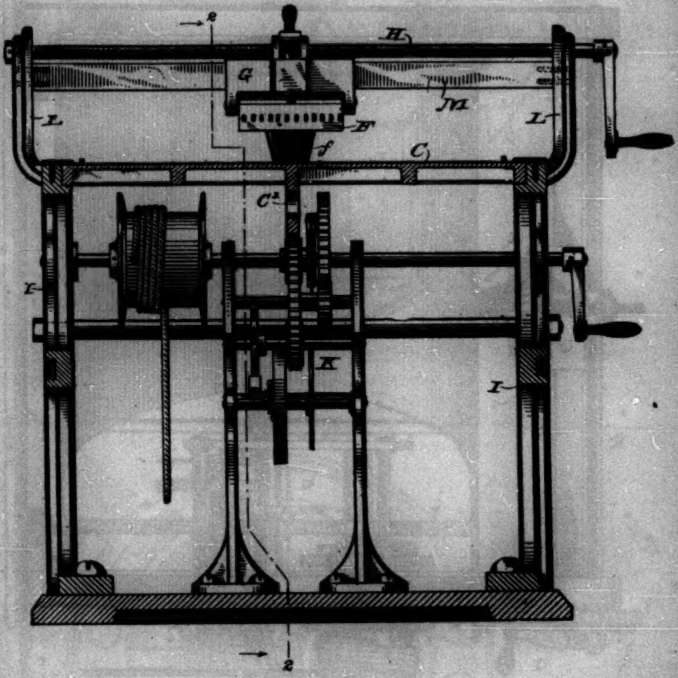


FIG. 6, DEVICE FOR RECIPROCATING MOTION OF TRANSMITTING AND RECEIVING APPARATUS.

A much neater and more practical method for obtaining the motion of the transmitting and receiving apparatus is shown in connection with Figs. 7, and 8. In this form the reciprocating motion of the preceding apparatus is replaced by a continuous rotary motion of the plate as will be explained.

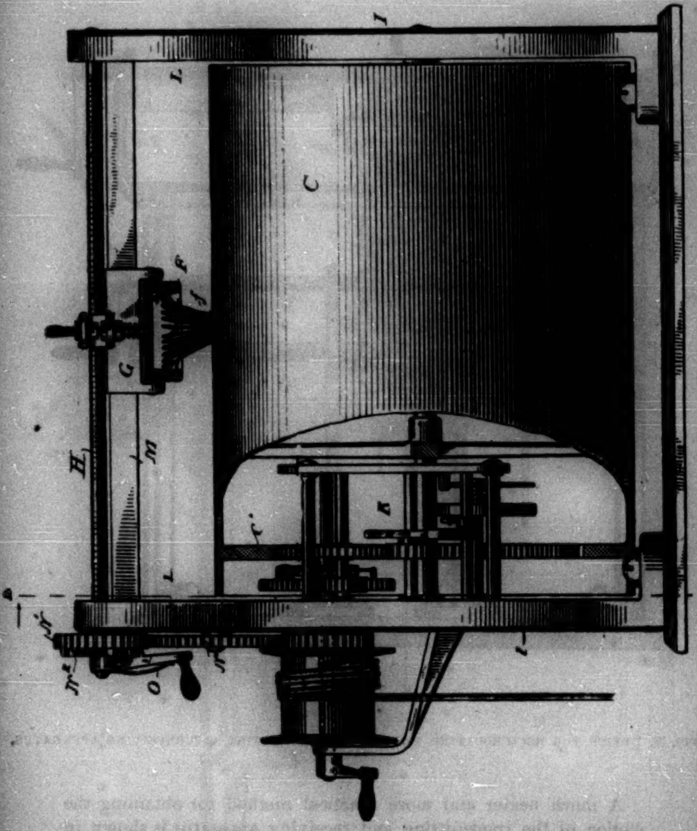

I
L
C
F
f
G
H
m
K
c'
L
l
o
m'

FIG. 7, DEVICE FOR ROTARY MOTION OF TRANSMITTING AND RECEIVING APPARATUS.

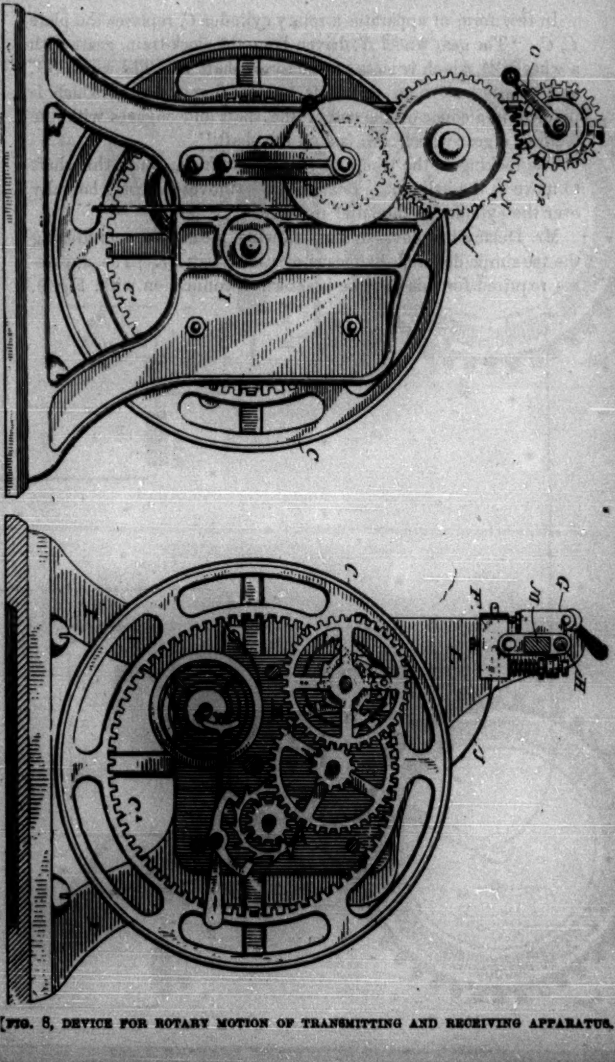

O
N
I
C'
C
C
F
G
M
E
H
J
C'

FIG. 8, DEVICE FOR ROTARY MOTION OF TRANSMITTING AND RECEIVING APPARATUS.

In this form of apparatus a rotary cylinder *C*, replaces the plate *C*, *C*. "The gear wheel *N*, driven from the clock-train, gears with a wheel N^1, which is loose on the screw-shaft *H*. The wheel N^1, is normally locked on the shaft by a spring catch, *O*, which is pivoted in a collar on the end of the shaft and engages with the teeth of a gear-wheel, N^2, fast on the shaft."

The locking of the wheel N^1, on the shaft *H*, causes this shaft to move as the cylinder is rotated, and so moves the comb laterally over the cylinder as the latter revolves.

Mr. Delany has devised the following means for reproducing the fac-simile despatch by means of a local battery. The apparatus required for this purpose is shown in connection with. Fig. 9.

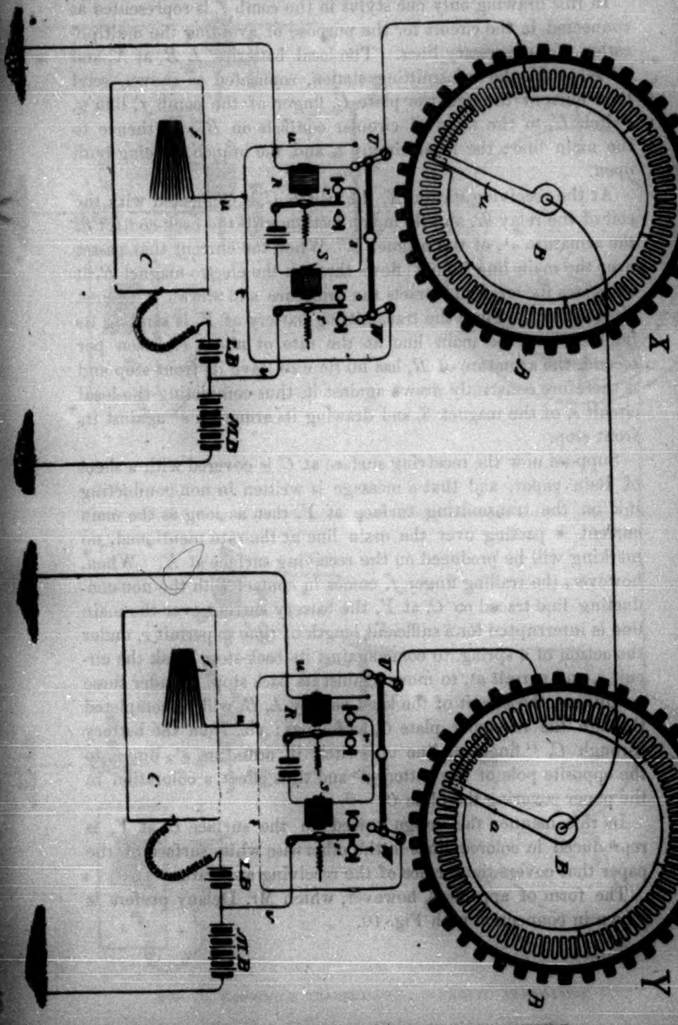

X
Y
R
B
a
C
f
LB
MB
U
W
S
r
s
t
u

FIG. 9, FAC-SIMILE REPRODUCTION BY LOCAL BATTERY.

In this drawing only one stylus in the comb *f*, is represented as connected in the circuit for the purpose of avoiding the multiplication of unnecessary lines. The local batteries *L B*, at *X*, and *M B*, at *Y*, the transmitting station, connected as shown, send their current through the plate *C*, finger of the comb *f*, line *u*, switch *U*, to the table of circular contacts on *B*, and thence to the main line; the local circuit *t*, and the branch *v*, being both open.

At the receiving station *X*, the switch *U*, is connected with the coil of the relay *R*, and *W*, in connection with the back-contact of the armature s^1, of the magnet *S*. When the current that passes over the main line from *Y*, flows through the electro-magnet *R*, it energizes its core and attracts the armature and draws it against its front stop. Since the transmitting battery at *Y*, is sending its impulse into the main line at the rate of about eighteen per second, the armature of *R*, has no time to leave its front stop and is therefore constantly drawn against it, thus completing the local circuit *s*, of the magnet *S*, and drawing its armature s^1 against its front stop.

Suppose now the receiving surface at *C*, is covered with a sheet of Bain paper, and that a message is written in non-conducting ink on the transmitting surface at *Y*, then as long as the main current is passing over the main line at the rate mentioned, no marking will be produced on the receiving surface at *X*. When, however, the trailing finger *f*, comes in contact with the non-conducting line traced on *C*, at *Y*, the battery current over the main line is interrupted for a sufficient length of time to permit *r*, under the action of a spring, to come against its back-stop, break the circuit *s*, and permit s^1, to move against its back-stop. Under these conditions, the circuit of the local battery *L*, *B*, will be completed through the receiving plate *C*, as follows: viz, from the battery through *C*, "finger *f*, line *ut*, switch *W*, armature s^1, line *v*, to the opposite pole of the battery;" and thus effect a coloration in the paper covering the plate *C*.

In this manner the design traced on the surface *C*, at *Y*, is reproduced in colored lines in the otherwise white surface of the paper that covers the surface of the receiving apparatus.

The form of apparatus, however, which Mr. Delany prefers is shown in connection with Fig. 10.

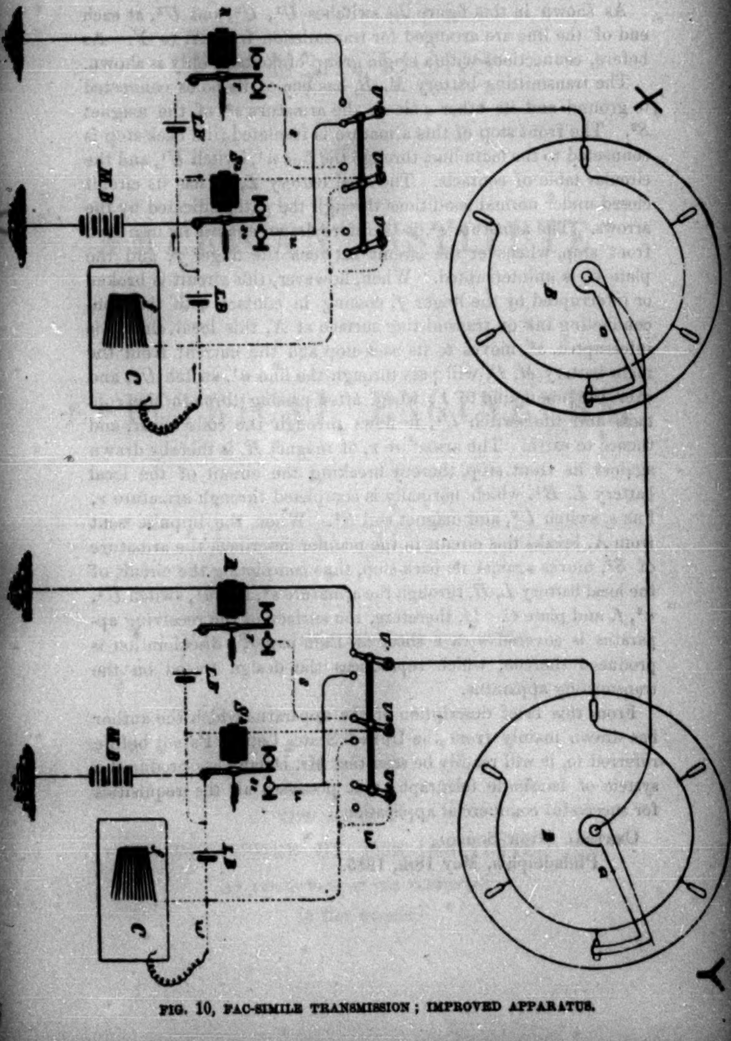

X
Y
R
S²
M B
L B
C
f
r
r²
s
n
D
m
B
a

FIG. 10, FAC-SIMILE TRANSMISSION; IMPROVED APPARATUS.

As shown in this figure the switches U^1, U^2, and U^3, at each end of the line are arranged for transmission from X, to Y. As before, connections with a single group of contacts only is shown.

The transmitting battery M, B, has one of its poles connected to ground and its other pole to the armature s^2, of the magnet S^2. The front stop of this armature is insulated; its back-stop is connected to the main line, through the line u^1, switch U^1, and the circular table of contacts. The local battery L, B, has its circuit closed under normal conditions through the path indicated by the arrows. The armature s^2, is therefore drawn against its insulated front stop, whenever the circuit between the finger f, and the plate C, is uninterrupted. When, however, this circuit is broken or interrupted by the finger f, coming in contact with the non-conducting ink on transmitting surface at X, this local circuit is interrupted, s^2, moves to its back-stop and the current from the main battery M, B, will pass through the line u^1, switch U^1, and over the main line to Y, when, after passing through the contacts and the switch U^1, it flows through the coils of R, and thence to earth. The armature r, of magnet R, is thereby drawn against its front stop, thereby breaking the circuit of the local battery L, B^1, which normally is completed through armature r, line s, switch U^2, and magnet coil S^2. When the impulse sent from X, breaks this circuit in the manner described, the armature of S^2, moves against its back-stop, thus completing the circuit of the local battery L, B, through the armature s^2, line u^1, switch U^3, u^2, f, and plate C. If, therefore, the surface of the receiving apparatus is covered with a sheet of Bain paper, a discoloration is produced thereon, which reproduces the design traced on the transmitting apparatus.

From this brief description of the apparatus which the author has drawn mainly from the United States Letters Patent before referred to, it will readily be seen that Mr. Delany has produced a system of fac-simile telegraphy that possesses all the requisities for successful commercial application.

CENTRAL HIGH SCHOOL,
Philadelphia, May 18th, 1885.